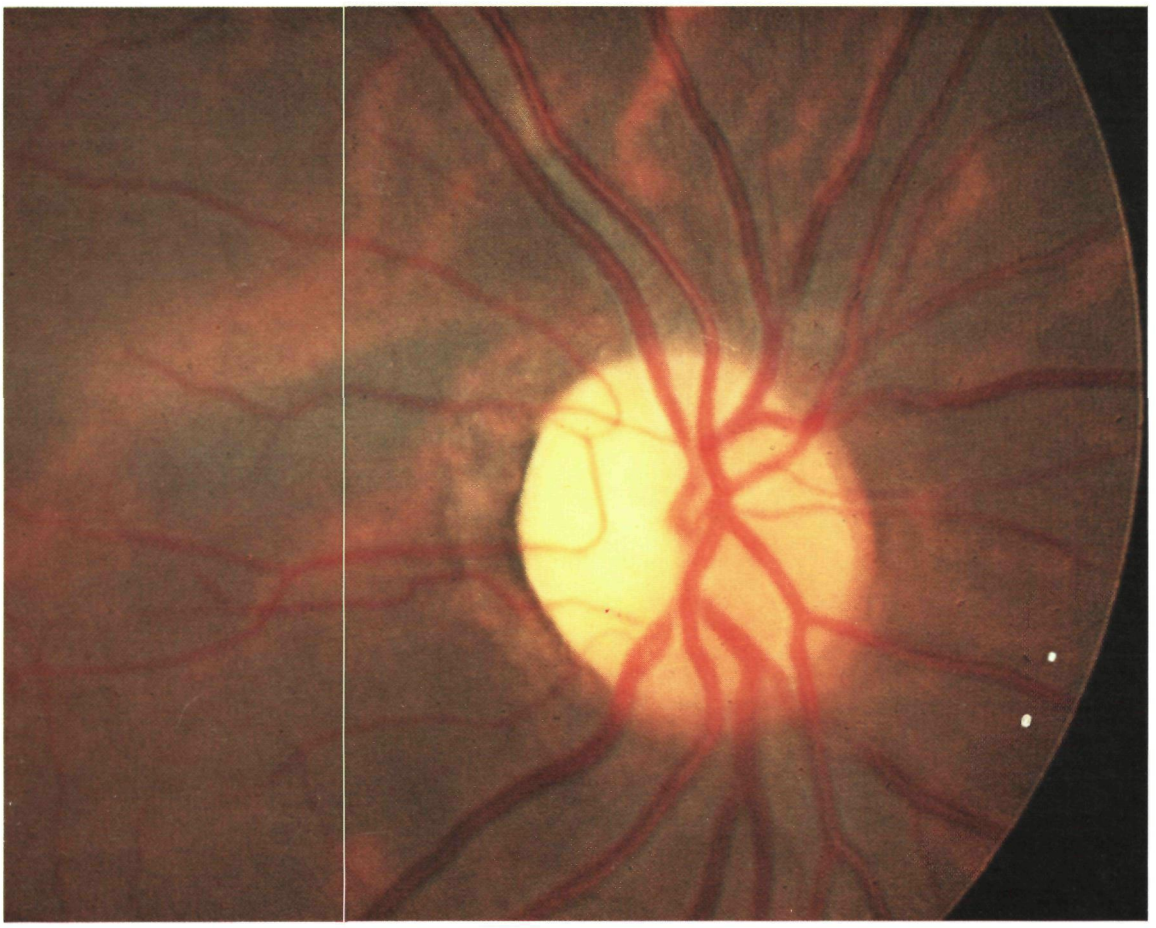
OPTIC ATROPHY IN SURINAME

F. HENDRIKSE



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OPTIC ATROPHY IN SURINAME

PROEFSCHRIFT

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IN DE GENEESKUNDE
AAN DE KATHOLIEKE UNIVERSITEIT VAN NIJMEGEN,
OP GEZAG VAN DE RECTOR MAGNIFICUS
PROF DR P G A B WIJDEVELD,
VOLGENS BESLUIT VAN HET COLLEGE VAN DECANEN
IN HET OPENBAAR TE VERDEDIGEN OP
VRIJDAG 28 MAART 1980
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DOOR

FRED HENDRIKSE

GEBOREN TE SINGAPORE

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Aan mijn ouders,
en aan Hilda, Karin en Jeroen

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Some institutions and persons who gave specialized assistance, are mentioned in the relevant passages of the text.

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Photograph II-1b was obtained by courtesy of the Rotterdam Eye Hospital, and photograph II-1c by courtesy of the Eye Clinic of the Amsterdam University Hospital (Wilhelmina Gasthuis). Photograph II-1a was made by Mr. A. L. Aan de Kerk, who also prepared the other photographs for publication.

Without the assistance of my wife, Hilda, in the extensive study of case records and in the field study, I could not have completed my investigations.

CONTENTS

INTRODUCTION

Optic atrophy has been described in the past hundred years in association with a wide variety of diseases and syndromes, and also often as an isolated finding. In many cases its aetiological classification is difficult, particularly in tropical developing countries where conditions for investigation are not optimal.

Especially in West Africa and Jamaica, reports in the past few decades have regularly mentioned endemic optic neuropathies and syndromes of which optic neuropathy constitutes a regular feature. In nearly all these cases, the aetiology is uncertain. For a better understanding of these affections it is of great importance that as many medical centres as possible in tropical countries describe them and comparable diseases and anomalies, and study the circumstances under which they occur.

A mobile eye unit visited several districts of Suriname from medio 1973 to 1977. During these visits the impression was gained that aetiologically unexplained optic atrophy was quite common. A substantial number of these patients had a serious to very serious visual handicap. Optic atrophy has never been a subject of systematic epidemiological and clinical research in Suriname, nor elsewhere in the northern part of the South American continent (at least not so far as could be deduced from literature in English). Suriname is special in that its population includes a wide variety of races. Particularly in the countryside, the various population groups are often still living in relative isolation, and in accordance with ancient customs and traditions. This made comparisons possible.

The problems encountered in the epidemiological and clinical field study were considerable. No random population samples could be obtained because no reliable records were available. This precluded the use of sophisticated statistical epidemiological methods. It was therefore evident in advance that only very marked differences in numerical data could be used for interpretation. Moreover, extensive laboratory work was impossible due to lack of funds and manpower.

The study was nevertheless undertaken because other requirements, perhaps equally important to ensure a reasonable chance of success in studying these population groups, were fulfilled. These requirements were:

a. a knowledge of local customs;
b. the trust of the population groups involved, because the various districts had been visited previously by the mobile eye unit.

If the latter requirement is not fulfilled, then any field study in the districts or in the interior of Suriname is bound to fail, however advanced the means available to the investigator.

This study does not claim to have covered the entire optic atrophy problem in Suriname. Medicine in Suriname, as in many developing countries, is in many fields still in the stage of clinical and epidemiological description of diseases. It is hoped, however, that this study may lay the foundations for additional, more aimed investigations in the future. Moreover, it has attempted to demarcate the area within which it may be possible to determine the cause of the type of optic atrophy so frequently encountered in the Creoles and Bush Negroes of Suriname.

SURINAME AND ITS INHABITANTS

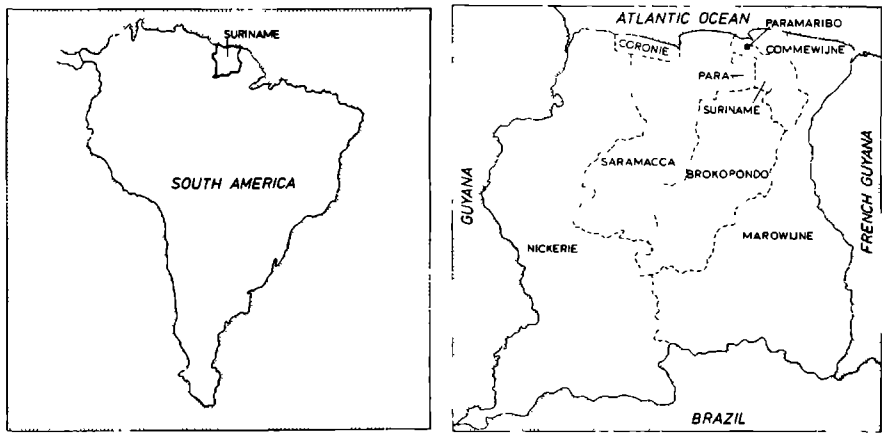
1. *Geography*

Suriname is situated between 2° and 6° north latitude and between 54° and 58° longitude west, on the north coast of the South American continent. It is bounded in the north by the Atlantic Ocean, in the south by Brazil, in the east by French Guyana, and in the west by Guyana (formerly British Guyana). Its surface area is 163,000 square kilometres.

The country can be divided into three geographical regions:

1. A coastal zone with a width of about 40 km, which encompasses most of the old plantations and new polders. This region comprises about 13% of the country's surface area, and is inhabited by 90% of the total population.
2. A savannah-like transitional region, thinly populated by, mostly, Indians.
3. About 100 km inland from the coast lies a region of dense tropical rain forest which is part of the northern Amazon forests. This region, which comprises about 80% of the country's surface area, is inhabited by a few tens of thousands of Bush Negroes and a few thousand Indians. Their settlements can only be reached by corial (a narrow dugout canoe, nowadays powered by an outboard motor) or by small planes.

FIG. I-1



The country is divided into nine districts: Paramaribo, Suriname, Nickerie, Coronie, Saramacca, Para, Brokopondo, Commewijne and Marowijne (fig. I-1). These districts differ in surface area and number of inhabitants.

2. *Climate*

Suriname has a tropical rain climate, with an annual mean day temperature of 27°C and a high relative humidity of the atmosphere (about 80%) (Ostendorf 1954; Emanuels 1968).

3. *Population*

At the last census (1971) the population consisted of 384,900 persons. During the years before and after 1975, however, large numbers emigrated to The Netherlands.

Table I-1 shows the composition of the population in 1971.

Creoles	118,500	30.8%
Hindustani	142,300	37.0%
Indonesians	58,900	15.3%
Bush Negroes	39,500	10.3%
Indians	10,200	2.6%
Chinese	6,400	1.7%
Europeans	4,000	1.0%
Others	5,100	1.3%
Total	384,900	100%

TABLE I-1. Composition of the population in 1971.

The capital Paramaribo has about 150,000 inhabitants if the adjacent suburbs are included.

4. *History*

The Guyana's were discovered by Spanish explorers about the year 1500. After a few brief periods of French and British rule, Suriname became a Dutch colony in 1668 and remained so until it attained independence on 25th November 1975.

Europeans established many agricultural projects in the 'West Indies', initially to cultivate tobacco and spices, but later mainly for the production of sugar. There was an immigration of white colonists: plantation owners and military personnel.

The native population - Indians - could not bear the heavy manual labour under plantation conditions. Consequently, West-African negroes were transported in large numbers to Suriname as slaves. Most of them came from the interiors of the Gold Coast and the Slave Coast of West Africa (Newbury 1966; Lombard 1967; Bascom 1969; Curtin 1971; De Groot 1974). This region now encompasses Ghana, Togo, Dahomey and Nigeria (fig. I-2).

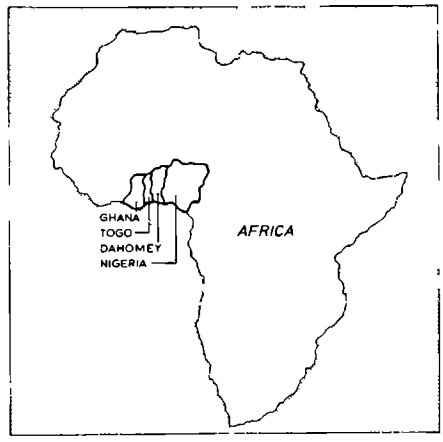


FIG. I-2

Some of these slaves managed to escape from their plantations and to survive in the jungle forest. They were the ancestors of the Bush Negroes now living in the interior.

Slavery was abolished in Suriname in 1863 (The former slaves, however, were under obligation to continue their work on the plantations until the end of 1873). This new situation forced the plantation owners to look for replacements, and they made agreements with Great Britain which enabled them to recruit British Indians as contract labourers for work overseas. The last transport of British Indian contract labourers reached Suriname in 1916. Until that time, some 34,000 Hindustani had been imported in 64 transports (Kruijer 1968).

When towards the end of the 19th century Great Britain intimated its wish to end the agreements, The Netherlands started the import of

labourers from what was then known as the Dutch Indies. Between 1890 and 1939, some 33,000 contract labourers, mainly from Java, reached Suriname. As early as 1850, moreover, some 500 Chinese had come to Suriname from Java. Immigration of Chinese direct from China started a few years after 1850 and continued until about 1870, when the Chinese government placed an injunction on further emigration of contract labourers. The total number of Chinese to arrive in Suriname was about 3,000. From other parts of the world, too, plantation workers came to Suriname. At about the time of the so-called negro emancipation (1873), a small group of Portuguese came from Madeira, and later on a group of Lebanese reached Suriname.

5. *Creoles*

In Suriname, the term Creole is used exclusively today in order to distinguish the negroid population group from the other ethnic groups.*

6. *Bush Negroes*

In this thesis, the Bush Negroes are considered as a separate group. As already pointed out, these inhabitants of the interior of Suriname are descendants of negro slaves who escaped from the plantations in earlier times (De Groot 1977).

* 'In the past, however, the term had an entirely different meaning. In the early days of the colonial era, it was used with reference to any person born in Suriname of white parents. The word Creole comes from the French 'créole', which in turn comes from the Portuguese adjective 'crioula', that is: 'not bought' (in other words: born and raised at home).

At a very early time, a distinction came to be made between Creole negroes (born in Suriname) and 'salt-water negroes' (imported from overseas). The Creole negroes soon came to exceed the whites in number and the term Creole - used as a noun - came to be associated primarily with descendants of African slaves, with admixtures of white and Indian blood. The term Creole probably developed on similar lines in North Brazil and in the West Indian Isles, where the negroid population group is likewise quite prominent.

In New World regions where the negroid population is small or non-existent, e.g. in the southern states of the USA, and in Venezuela, Colombia, the Andes Republic, Chili and Argentina, the term Creole has continued to be used with reference to a native-born white.' (Buschkens, as quoted by Helman [1977]).

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ANATOMY, PATHOLOGY AND FUNCTION TESTS OF THE OPTIC NERVE

1. *Macroscopic anatomy*

The optic nerve (fasciculus opticus) is essentially an extension of the white matter of the brain. Its length from the lamina cribrosa to the optic chiasm averages about 5 cm. It enters the eye 3 mm on the nasal side of the optical axis.

Particularly the intracranial part of the optic nerve and the chiasm have many important relations to adjacent cerebral, vascular and osseous structures.

The optic nerve is enveloped by three membranes: dura mater, arachnoidea and pia mater. The pia mater is the most vascularized of these three membranes.

2. *Microscopic anatomy*

The optic nerve consists of a total of about 1.200.000 nerve fibers (Oppel 1963, Potts 1972). The counts are based on the number of myelin sheaths. Electron microscopy confirms that there are also no image information bearing fibers without myelin (Cohen 1967). Autonomic nonmyelinated nerve fibers do exist around the central retinal artery but these are not in significant numbers (Ikui 1964, Cohen 1967).

The nerve fibres of the ganglion cells in the macular region extend direct to the optic disc. The temporal quadrant of the nerve fibre layer of the optic disc therefore consists of the so-called papillomacular bundle.

The nerve fibres are myelinated from central to immediately behind the lamina cribrosa. Myelination is not complete until about the 10th week after birth (Mann 1928). At birth, only the macular fibres already have a myelin sheath (Bembridge 1956). The myelination of the fibres of the optic nerve is identical to that in the white substance of the other tracts in the spinal cord and brain (Walsh & Hoyt 1969). The function of the myelin, however, is not yet entirely clear.

To be distinguished are:

a. Visual (afferent) fibres which extend to the lateral geniculate body.
b. Pupillary (afferent) fibres which extend to the mesencephalon (Cogan 1966; Loewenfeld 1969).
c. Centrifugal (efferent) fibres (Wolter 1960, 1979; Walsh & Hoyt 1969) with a possible inhibitory feedback action on the system that regulates the output of the receptors and the input of the ganglion cells (Granit 1955, 1962; Ogden 1964, 1966; Van Hasselt 1972).

The structure of the optic nerve differs from that of the white matter of the brain in that it is characterized by an extensive network of connective tissue septa. Unlike the peripheral nerves, the optic nerve contains no Schwann cells.

3. Vascularization

The vascularization of the optic nerve has been studied in detail by Hayreh (1962, 1969a, 1969b, 1970, 1974a, 1974b, 1975, 1978a, 1978b), whose observations seem to be among the most accurate in the literature.

Hayreh found that the lamina cribrosa and the prelaminar area were supplied exclusively by the posterior ciliary arteries, either directly or via the peripapillary choroidea. Moreover, these arteries proved to be the principal (and possibly the only) vascularization of the retrolaminar area. Part of the temporal superficial nerve fibre layer can also be supplied by these arteries. This layer is principally supplied by branches of the peripapillary retinal arterioles. As a rule, two or three posterior ciliary arteries arise from the ophthalmic artery. The orbital part of the optic nerve is vascularized by pial vessels. This blood comes from intraorbital branches of the ophthalmic artery. In 75% of cases, the central retinal artery has 1-7 centrifugal branches in the intraneuronal part of the optic nerve. This central retinal artery enters 5-15 mm behind the bulb. The intracanalicular part is vascularized by branches of the ophthalmic artery and orbital arteries. The intracranial part is supplied by the ophthalmic artery, the anterior superior hypophyseal artery and other adjacent intracranial arteries.

Apart from the blood flow, an anterograde and retrograde flow of fluid has been demonstrated in the axons of the optic nerve: the so-called axoplasmic flow (Minckler 1976a, 1976b; Tso 1977; Hayreh

1978a). This flow of fluid has its origin in the ganglion cells of the retina.

4. *Optic atrophy*

Atrophy of the optic nerve can be associated with many neurological, neuroretinal and internal diseases, and with pathological nutrition and intoxications. The optic nerve is also highly vulnerable to traumatic lesions. Its regenerative power is very limited because it consists of highly differentiated structures.

It is seldom possible to reach a definite conclusion about the aetiology on the basis of ophthalmoscopic findings; and even after further clinical examination the aetiology often remains uncertain (Caroll 1952: Aetiology of optic neuritis unexplained in 30% of a series of 240 cases. Rothahn 1960: 26.7% of cases of bilateral 'neuritis' unexplained; neuritis led to optic atrophy in 60% of the cases. Ragnetti 1964: aetiology obscure in 38% of cases of neuritis and 16.4% of cases of optic atrophy. Quéré & Diallo 1967: in 450 cases of optic neuritis seen in Senegal between 1961 and 1968, the aetiology was obscure; optic atrophy gradually developed in more than 200 of these cases. Busse 1979: aetiology of optic neuritis unexplained in 50% of a series of 71 cases).

5. *Pathological anatomy*

On the basis of the pathological anatomy, three types of optic atrophy can be distinguished:

a. If nerve fibres degenerate quickly, the central cylinder (axon) disappears and demyelination occurs. The microglia present then phagocytizes the vestiges of the neural elements. Proliferation of astrocytes at the periphery of the atrophic area then gives rise to disorderly arranged glia tissue which replaces the neural elements (Walsh & Hoyt 1969; Duke Elder 1971).

b. If degeneration is slow, the space lost is accurately filled by glia tissue: so-called columnar gliosis (Walsh & Hoyt 1969; Duke Elder 1971).

c. If the circulation has become insufficient, as in ischaemic optic nerve disease and glaucoma, then cavernous or lacunar atrophy develops (Kalvin 1966). In these cases there is virtually no loss of

volume of the optic nerve In acute glaucoma, cavernous atrophy develops and the spaces are filled by mucopolysaccharides (Zimmerman 1967; Lampert 1968).

Axon degeneration in optic atrophy causes orthograde and retrograde degeneration which finally also involves the nerve fibre layer (Hoyt 1972, 1973, 1976; Frisch 1974; Newman 1977; Frisén 1979).

6 *Ophthalmoscopic evaluation of the optic disc*

There are marked physiological variations in the colour of the optic disc Whether the appearance of the optic disc is or is not pathological can therefore only be decided when the fundi are daily examined (i.e. negroid in our study of optic atrophy in Suriname). In some cases the optic disc is so pale that a pathological condition is quite evident. The difficulties arise when the pallor of the optic disc is less pronounced.

We have unsuccesfully attempted to objectify the optic disc appearance by the Kestenbaum method (counting the number of arterioles traversing the disc margin: normally about 10). In many cases in which the disc presented an entirely normal appearance, however, the number of small vessels extending over the margin of the disc was nevertheless <9 Ophthalmoscopic examination, especially with red-free light, can directly visualize morphological changes in the nerve fibre layer of the retina (Frisén 1979).

Dekking wrote in 1947 that 'describing slight atrophy of the optic disc is merely describing slight hypertrophy of the investigator's self-confidence'. It would nevertheless be wrong to interpret all suspect cases of optic atrophy as normal, particularly when visual acuity is diminished

Figure II-1 presents examples of a normal negroid optic disc, a disc with temporal pallor and a disc suspected of temporal pallor.

The ophthalmoscopic picture of total or partial pallor of the optic disc can be caused by a decreased number of papillary capillaries, a gleam of the lamina cribrosa through a thin nerve fibre layer, development of glia tissue, or the use of short-wave light (Sachsenweger 1972).

In cases characterized solely by a moderately pale optic disc or one that already tends to appear whitish, the description is best limited to the term

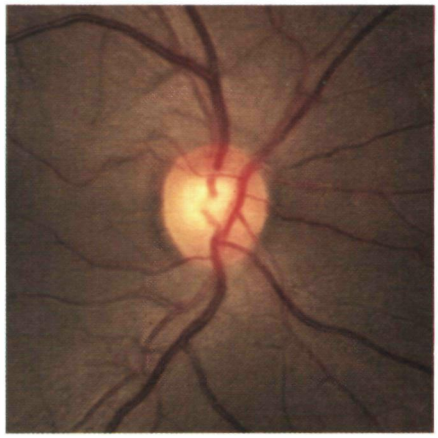

FIG. II-1a. Normal negroid optic disc.

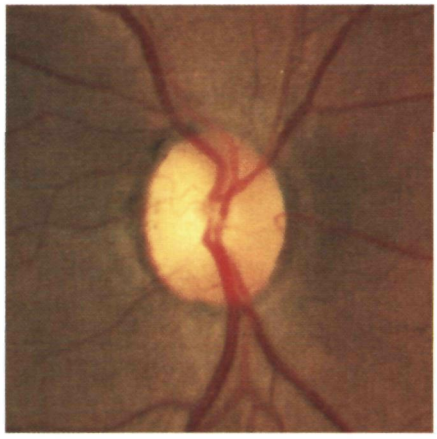

FIG. II-1b. Suspected temporal pallor of the optic disc.

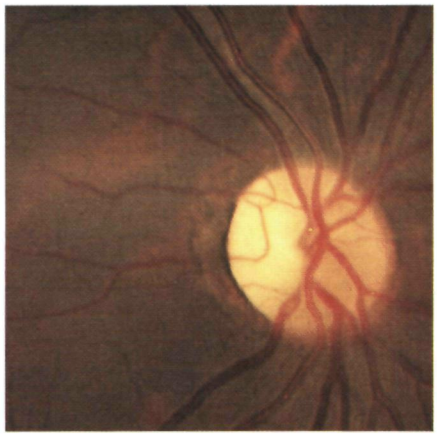

FIG. II-1c. Temporal pallor of the optic disc.

'pale optic disc'; the term optic disc atrophy (optic atrophy) should be reserved for cases in which loss of optic nerve function is demonstrable in addition (Mooney 1965; Walsh & Hoyt 1969; Duke Elder 1971).

7. *Function tests*

Parameters of optic nerve function are:

a. Pupillary reactions
b. Visual acuity
c. Visual fields
d. Colour vision
e. Visually evoked cortical potentials (VECP), if considered in conjunction with the electroretinogram (ERG).
f. Fluorescence angiography, which may reveal pathological changes of the capillary bed of the optic disc (Archer 1972; Hayreh 1975).

a. Pupillary reactions

Only pupillary reactions that test the afferent impulses are of importance in evaluating the function of the optic nerve. This is because the afferent impulses are transmitted via the optic nerve, while the efferent impulses travel via the oculomotor nerve.

In an eye with disturbed afferent impulse transmission, the following reaction types can be distinguished:

1. The direct light reaction of the affected eye and the consensual light reaction of the unaffected eye are diminished or abolished.
2. The consensual light reaction of the affected eye and the near effect are normal.
3. The initial constriction upon illumination of the affected eye can be of increased latency and with reduced amplitude (low-intensity reaction) and of reduced duration (so-called pupillary escape) (Thompson 1966, 1976; Ellis 1979).
4. Rapidly alternating illumination from the unaffected to the affected eye (so-called swinging flashlight test) causes dilatation of both pupils because the brain signals a light reduction (Loewenstein 1954, 1958; Levatin 1959; Thompson 1966, 1975, 1976; Glaser 1977; McCrary 1977).

In the case of asymmetrical abnormalities, the swinging flashlight

test is a highly sensitive method to demonstrate afferent disturbances. However, there is by no means always a satisfactory correlation between decreased visual acuity and a disturbed afferent pupillary reaction (Thompson 1975).

Unilateral and bilateral total or partial optic nerve lesions are often accompanied by changes in the first rapid contraction phase of the pupillary reaction (Thompson 1966, 1976; Sachsenweger 1972).

Of the various more specific abnormalities in pupillary reactions we only mention the so-called Argyll Robertson pupil, which will play a role in our discussion of the aetiology of optic atrophy. A typical Argyll Robertson pupil can be defined as a pupil with a miosis of less than 3 mm in twilight, unresponsive to light and showing an unaffected (or even an enhanced) convergence reaction (Argyll Robertson 1869; Loewenfeld 1969; Duke Elder 1971).

An exhaustive review of the literature by Loewenfeld (1969), which covered 2433 publications, showed that the large majority of patients with Argyll Robertson pupils were suffering from tabes dorsalis, general paresis or cerebral syphilis. However, typical Argyll Robertson pupils had also been found - if less often - in patients with diabetes mellitus, various types of encephalitis, multiple sclerosis and a rare group of neuromuscular diseases (Déjérine-Sotta and Charcot-Marie-Tooth disease). The incidence of typical Argyll Robertson pupils in tabes dorsalis is high, the data in the literature ranging from 48% to 80%. In congenital syphilis, however, Argyll Robertson pupils are rare (Nonne 1919).

b. Visual acuity

The degree of pallor of the optic disc depends on, among other factors, the number of degenerated nerve fibres per unit of surface area. The disc may show unmistakable pallor while visual acuity is hardly affected, if at all, because the papillomacular fibres have remained intact. On the other hand, selective degeneration of the papillomacular fibres can give rise to diminished visual acuity while temporal disc pallor may be only slight.

The above indicates that there may be a marked discrepancy between the appearance of the optic disc, and visual acuity.

c. Visual fields

Dependent on the localization of the lesion, optic atrophy can give

rise to a wide variety of visual field defects. There are reports on concentric, irregular peripheral and nasal defects, on various types of hemianopsia, on central and paracentral relative and/or absolute scotomas and total or central decreases in sensitivity (Chamlin 1953; Mooney 1965; Sachsenweger 1972).

The characteristic field defect in nutritional neuropathy is a bilateral, almost symmetric, centrocaecal scotoma, with preservation of the peripheral field (Carroll 1966). Aulhorn (1976) found that relative central scotomas occur mainly in optic neuropathies due to poor vitamin B_{12} absorption, e.g. in pernicious anaemia, whereas absolute central scotomas occur only in vitamin B_{12} deficiencies caused by tobacco/alcohol consumption. Also heredo-degenerative and acute demyelinating lesions tend to effect the papillomacular bundle in the optic nerve, and therefore produce central scotomas. Concentric peripheral field defects are often the primary symptom of optic atrophy (Sachsenweger 1972). Hayreh (1975) studied patients with anterior ischaemic optic neuropathy and he found lower visual field defects in the majority of cases. His findings in 26 eyes with anterior ischaemic optic neuropathy were:

lower visual field defects	: 50 % (13 eyes)
upper visual field defects	: 11.5% (3 eyes)
defects with a vertical boundary	: 11.5% (3 eyes)
central scotomas	: 19.3% (5 eyes)
other defects	: 7.7% (2 eyes)

Other authors found also that lower visual field defects are found in the majority of cases of ischaemic optic neuropathy (Lasco 1961; Bonamour 1966; Miller 1966; Foulds 1969).

d. Colour vision

Colour vision can be affected in a fairly early stage, often even before visual acuity is diminished (Sachsenweger 1972; Glaser 1977). It was long believed that retinopathies are associated with disturbed blue-yellow vision, and optic neuropathies with disturbed red-green vision, but this differentiation is too general and too simplistic (Koellner 1912; Jaeger 1956; Hong 1957; Verriest 1963, 1964; Waardenburg 1963; Linksz 1964; Duke Elder 1971; Krill 1971).

The fact that retinopathies are often associated with disturbed blue-yellow vision could in part be explained by the fact that they are often characterized by exudates that can act as yellow filter. Several investi-

gators however (Koellner 1912; Verriest 1964; Pinckers 1971; Krill 1972) regularly found type II red-green disorders (deutan-like), in optic neuropathies not associated with retinal pathology, whereas almost exclusively type I red-green disorders (protan-like) were found in central receptor dystrophies.

In acquired colour vision disorders, both blue-yellow and red-green discrimination are often disturbed, whereas congenital defects are usually confined to disturbed red-green discrimination (Krill 1972).

According to the literature (Jaeger 1954, 1955, 1956, 1976; Kjer 1956, 1959; François 1961; Grützner 1963), patient with an autosomal dominant hereditary optic atrophy as a rule show a disturbed blue-yellow discrimination type III.* A few reports, however, present pedigrees in which this type III disturbance did not seem to be characteristic for this type of optic atrophy. A few families have been described with type I disturbances in autosomal dominant hereditary optic atrophy (Kok-Van Alphen 1960, 1970, 1972; Aulhorn 1969; Völker-Dieben 1974, 1978); and also a few families with type II disturbances (Früh 1972; Jaeger 1972).

In Europe, hereditary red-green disorders occur in 8% of the males and 0.4% of the females (Waaler 1927 in Norway; Von Plata 1928 in Switzerland; Schmidt 1936 in Germany; Nelson 1938, Vernon 1943 in Great Britain; François 1958 in Belgium). The difference in incidence can be explained by the mode of hereditary transmission. Hereditary red-green disorders are recessive X-chromosomal (Fransceschetti 1957).

For our study in Suriname it is of importance to know that differences in incidence of hereditary disorders of colour vision have been found between different races. Duke Elder's 'System of Ophthalmology' (1968) mentions a number of studies of the incidence of colour vision disorders in different races. The male incidence of hereditary red-green disorders is 3.7% in American negroes, 3.9% in Japanese, 4.9% in Chinese, 1.7% in Congolese, 1.8% in Ugandese, 1.0% in Fijians, and 1.0% in Eskimos. In India, the same percentages are found as in Europe. Mexican urban males show an incidence of 4.7-7.7%, whereas males in the interior show an incidence of 0-2.3%.

The low incidence of red-green disorders in population groups who until recently have lived in primitive conditions has occasionally been

* This term is used here in accordance with the literature; the term disturbed blue-green discrimination would be better (Wright 1979).

explained oecologically, as resulting from natural selection based on inability to discriminate red and green (with regard to poisonous fruits, for example) (Mann 1956).

e. Visually evoked cortical potentials

Examination of visually evoked cortical potentials (VECP) can provide data on the presence or absence of a conduction disorder. However, this test is still of only limited significance in the case of bilateral abnormalities. The VECP pattern shows marked inter-individual variations, and is even believed to show intra-individual fluctuations (Potts 1967; Krill 1972).

In normal persons, the OD and OS pattern is symmetrical and this is why a VECP test is of diagnostic significance in unilateral conduction disorders. Since the introduction of pattern stimulation (pattern evoked responses), however, the sensitivity of the test has increased (Rietveld 1967; Harter 1968, 1970; Venoyma 1970; Krill 1972), although the specificity of a VECP test with pattern stimulation is still low (Halliday 1976; Wildberger 1977; Van Lith 1978).

Besides a VECP test, an electroretinogram (ERG) can also be of diagnostic importance. For example, the ERG is abnormal in a late stage of sex-linked optic atrophy, which also shows VECP changes (Völker-Dieben 1978). In recessive hereditary optic atrophy, too ERG changes can ultimately develop (Van Lith 1978). In alcohol intoxication, too, abnormal VECP findings have been obtained in combination with ERG changes (Van Lith 1978, Henkes 1979).

Although the available knowledge of the VECP test is not yet sufficient to warrant too many conclusions, it should be realized that the importance of this test lies in the fact that it may be abnormal while the clinical pathology is so slight that other tests still give normal results (Halliday 1972, 1973, 1976; Bornstein 1975).

f. Fluorescence angiography

Fluorescence angiography can provide data on the vascularization and circulation of the optic disc. Three vascular complexes contribute to the fluorescence of the optic disc: the capillaries of the lamina cribrosa and the prelaminar area, the retrolaminar area and the superficial nerve fibre layer (see Section 3, this chapter).

Fluorescence angiography discloses the disappearance of super-

ficial and deeper capillaries in the case of optic atrophy. Reduced background fluorescence during the arterial phase of angiography is suggestive of pathological changes of the deeper ciliary and choroidal capillaries. Reduced fluorescence during the arteriovenous phase indicates pathological changes of the superficial retinal capillaries of the disc.

During the late venous phase, the fluorescence of a normally vascularized optic disc is more intensive than that of the peripapillary choroidea. In optic atrophy, however, the papillary fluorescence during the late venous phase is less intensive than that of the peripapillary choroidea (Hayreh 1969a, 1975; Archer 1972).

There are a few reports on fluorescence-angiographic findings which may be specific for a particular aetiology of optic atrophy. In patients with dominant (juvenile) optic atrophy and type I colour vision disorder, Kok-Van Alphen et al. (1972) found late diffuse fluorescence of the disc, persisting longer than 15 minutes after fluorescein injection. In patients with dominant (juvenile) optic atrophy and type III colour vision disorder, this finding was not obtained (Jaeger 1972; Ruf 1973), but good correlations were found between visual acuity and disc vascularization. The fluorescence-angiographic findings, however, warranted no conclusions regarding the pathogenesis and localization of the abnormality (Jaeger 1978).

In Leber's disease, circumpapillary microangiopathies (telangiectases and tortuosity) and swelling of nerve fibres without leakage were described (Lawton-Smith 1973; Nikoskelainen 1974). Other authors (Oosterhuis 1972; Jaeger 1972; Ruf 1973) saw an abnormally hyperfluorescent band along the edge of the optic disc during the late phase of fluorescence angiography.

Generally, however, the various types of optic atrophy cannot be adequately differentiated on the basis of fluorescence angiography.

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AETIOLOGY OF OPTIC ATROPHY

1. *Methods of classification*

Since our study concerns patients with optic atrophy of unknown origin, it is useful to provide a schematic survey of various possible types of optic atrophy, against which our findings can be tested. The literature shows that several different schemes are in use, on the one hand due to the vast number of diseases associated with optic atrophy, and on the other hand due to inadequate knowledge of the underlying pathology. In principle, the choice is between three classifications: according to histological, according to clinical, and according to aetiological criteria.

The merit of a classification on the basis of histological criteria lies in the objectivity of these criteria. Unfortunately, however, this classification is not practicable because the pathological anatomy is known in only a small number of cases of optic neuropathy. Moreover, a classification of this kind should exceed the three categories now know (see Chapter II) to ensure adequate differentiation of the scores of abnormalities.

A clinical classiciation would be practical for the clinician, but the various forms in which optic nerve processes manifest themselves are limited, and sharp differentiation is therefore not possible on this basis.

The advantage of an aetiological classification is that several conditions with similar characteristics can be lumped together. For use in actual practice, we prefer an aetiological classification to the abovementioned alternatives.

An attempt has been made to include as many conditions as possible in the following scheme. However, diseases in which optic atrophy has been only sporadically described, are not included.

2. *Aetiological classification of optic atrophy*

I Demyelination
II Vascular aetiology
III Tumours
IV Intoxications
V Hereditary forms
VI Traumatic aetiology
VII Inflammatory aetiology
VIII Metabolic aetiology
IX Systemic non-infectious diseases
X Tapetoretinal and neuroretinal degenerations

I. Demyelination

a. Due to unknown causes

1. Multiple sclerosis
2. Acute disseminated encephalomyelitis
3. Neuromyelitis optica (Devic's disease)
4. Diffuse periaxial encephalitis (Schilder's disease)
5. Leucodystrophies (e.g. Pelizaeus-Merzbacher's and Krabbe's disease)
6. Spinocerebellar degenerations (Marie's disease and Friedreich's ataxia)
7. Carcinogenic demyelination

b. Due to viral infections

1. Measles
2. Mumps
3. Smallpox
4. Herpes zoster
5. Chicken-pox

c. Due to bacterial infections

1. Meningococcal meningitis
2. Botulism
3. Pertussis
4. Bacterial endocarditis
5. Brucellosis

d. Due to rickettsiae

1. Typhus fevers

e. Due to protozoa

1. Malaria
2. Trypanosomiasis
3. Acquired toxoplasmosis

f. Due to filariases

1. Onchocerciasis

II. Vascular aetiology

a. Decreased perfusion pressure

1. Due to decreased blood pressure:
a. Severe haemorrhage
b. Cardiac failure
c. Anaesthesia
d. Vascular occlusion (carotid artery)

2. Due to increased resistance in the optic disc:
a. Sclerosis of the posterior ciliary arteries
b. Giant-cell arteritis
c. Periarteritis
d. Vascular occlusion or stenosis of central retinal artery and/or vein
e. Increased intraocular pressure
f. Increased blood viscosity (Waldenström's macroglobulinaemia, multiple myeloma, cryoglobulinaemia, polycythaemia, Hodgkin's disease, leukaemia)

b. Disturbed oxygenation of blood

1. Severe anaemia
2. Lung diseases

III. Tumours

a. Of the optic nerve and chiasm

1. Metastases
2. Glioma
3. Meningioma
4. Lymphoma

5. Fibromatosis
6. Cysts of the optic nerve

b. Intracranial tumours not involving optic nerve and chiasm

1. Craniopharyngioma
2. Other hypophyseal tumours (adenomas, endotheliomas)
3. Cerebral tumours
4. Aneurysms

IV. Intoxications

1. Antimony
2. Arsenic
3. Aspidium (Dryopteris filix-mas)
4. Barbiturates
5. Carbon disulphide
6. Carbon monoxide
7. Carbon tetrachloride
8. Chloramphenicol
9. Clioquinol (Enterovioform®)
10. Cyanide
11. Dinitrobenzene
12. Disulfiram (Antabuse®)
13. Ethambutol (Myambutol®)
14. Ethanol
15. Ethylhydrocupreine hydrochloride (Optochin®)
16. Iodoform
17. Isoniazid
18. Lead
19. Methanol
20. Monoamine oxidase inhibitors
21. Plasmocid
22. Quinine
23. Streptomycin
24. Sulphonamides
25. Thallium
26. Tobacco
27. Trichloroethylene

V. Hereditary forms

a. Autosomal dominant optic atrophy (infantile, possibly sometimes congenital)
b. Optic atrophy with deafmutism (autosomal dominant)
c. Autosomal recessive optic atrophy (congenital or early juvenile)
d. Behr's complicated optic atrophy (autosomal recessive)
e. Optico-oto-diabetic syndrome (Wolfram's syndrome)
f. Leber's disease
g. X-linked optic atrophy
h. Optic atrophy in heredofamilial degenerative diseases of the CNS
i. Optic atrophy associated with heredofamilial skeletal anomalies
j. Optic atrophy associated with one of the following hereditary diseases:
Albright's disease
Bloch-Sulzberger Syndrome
Cockayne's disease
cri du chat syndrome
glucose-6-phosphate dehydrogenase deficiency
homocystinuria
hypertelorism (Greig's syndrome)
Menkes' disease
microcephaly
neurofibromatosis
opticocochleodentate degeneration
acute intermittent porphyria
porphyria and conjunctival-scleral necrosis

VI. Traumatic aetiology

a. Lesion of the optic nerve
b. Haemorrhage in the nerve sheath
c. Fracure of the optic canal
d. Evulsion of the optic nerve

VII. Inflammatory aetiology

a. Neuritis or perineuritis due to:

1. Intraocular inflammation
2. Orbital inflammation
3. Inflammation of the nasal sinuses
4. Inflammation of the meninges
5. Septicaemia

b. Specific infections:

1. Syphilis
2. Tuberculosis

VIII. Metabolic aetiology

a. Nutritional deficiencies: a. vitamins
b. proteins
b. Diabetes mellitus
c. Pernicious anaemia
d. Endocrine disorders (thyroid dysfunction; pregnancy and lactation)
e. Metabolic storage diseases

IX. Systemic non-infectious diseases

a. Sarcoidosis
b. Sickle-cell anaemia
c. Collagen diseases

X. Tapetoretinal and neuroretinal degenerations

a. Rod-cone dystrophy (retinitis pigmentosa)
b. Leber's congenital amaurosis
c. Progressive cone dystrophy
d. Sex-linked juvenile retinoschisis

DESIGN AND METHOD OF THE RETROSPECTIVE STUDY AND THE FIELD STUDY

1. *Origin of the data of the retrospective study*

In the retrospective study, efforts were made to collect as many data as possible on the incidence, types and aetiology of optic atrophy in Suriname during the period 1950 through 1976. These data came from three available sources:

1. the records of the ophthalmological out-patient clinic of the Academic Hospital, Paramaribo (known as National Hospital from 1950 to 1968, and as Academic Hospital thereafter), covering the period 1958 through 1976.
2. The records of a number of private practices, covering the period 1971 through 1976.
3. The records of the mobile eye unit, covering the period 1974 through 1976.

These records gave access to data on some 120,000 patients of the Academic Hospital, 28,914 patients in private practices, and 3,973 patients seen by the mobile eye unit. The descriptive-statistical processing for the epidemiological part of the study was done in cooperation with the mathematical-statistical advice department (MSA) of the University of Nijmegen (W. H. Doesburg and W. A. J. G. Lemmens).

2. *Method of the field study*

The retrospective data were supplemented with data obtained in a field study of the familial occurrence of optic atrophy in a few families in the district Para. An analysis of the data from the records had shown that optic atrophy was quite common in the district Para, and in particular in some families. Since this district had been less rigorously depopulated by migration to Paramaribo City than the other districts, a family study here seemed to open perspectives, particularly since I had personal contacts with some of the local confidential re-

presentatives; motivating people to participate in a detailed family study might therefore meet less resistance than elsewhere.

I settled down in the district from February through June 1977, during which period efforts were made to trace:

a. optic atrophy patients who had come to the mobile eye unit when I visited the district in 1974;

b. the members of the three families in which, according to the retrospective study, optic atrophy occurred frequently.

3. *Origin of the data of the family study*

The pedigrees of these three families were composed with the aid of the following data.

Data from the civil registry records.

Data from the so-called register of the plantation 'Onverwacht'. This register, the contents of which are accessible exclusively via mediation by a confidential representative of this plantation, contains family data dating back to the abolition of slavery in Suriname in 1863. In particular it also lists the so-called 'illegitimate' children, whose names are not in the civil registry records.

Family books, which were introduced about 1920. Upon notification of the birth of a legitimate or illegitimate child, the civil registry officer in the district in question recorded the particulars (father, mother, name and date of birth) in this book. In the case of death, too, the personal data were recorded in it. Experience had shown that the families were attached to these books and took good care of them. They often contained data not found in the civil registry records.

The so-called 'slave records', which contain family data dating back to about 1790 - long before abolition of slavery in Suriname in 1863.

Pedigrees composed during land expropriation procedures in 1960, on behalf of bauxite mining by the Suriname Aluminium Company (SURALCO).

In addition, it was often necessary to rely on verbal tradition, which had to be verified afterwards.

The composition of these pedigrees and the tracing of the persons in question took place under climatological and geographical conditions which can be described as very difficult. Large distances often

had to be travelled by car, on foot or by corial. Nevertheless, virtually complete pedigrees were composed for two of the three families.

In every accessible person, the appearance of the optic disc was examined. If it seemed abnormal, the person in question was taken along to the central post in the district, where a (somewhat primitive) examining room had been set up. Here, ophthalmoscopy was again performed now in mydriasis, and the further ophthalmological and physical examination was made. If there was ophthalmoscopic evidence of a pale optic disc, the patient was taken along to the Academic Hospital in Paramaribo, where further examinations were made. In toto each examination took about 10 hours per person, divided over several days.

In this way, 65 persons were given an extensive examination (ophthalmoscopy was carried out in 449 persons in the three families). Of the persons in whom ophthalmoscopy had not revealed optic atrophy, the relevant clinical data were recorded, if possible.

EPIDEMIOLOGY

1. *Introduction*

As pointed out in chapter IV, the records of the department of ophthalmology of the Academic Hospital (AH) in Paramaribo over the period 1950-1976, those of a number of private practices (PP) over the period 1971-1976, and those of the mobile eye unit (MEU) over the period 1974-1976, were examined in order to identify persons in whom optic atrophy (OA) had been diagnosed during the period indicated.

Of the data thus collected, the following are of importance for the epidemiological analysis:

The year in which OA was diagnosed.
The age at which OA was diagnosed.
The patient's sex.
The district of origin.
The patient's race.

In addition, efforts were made to establish whether the aetiology of the OA diagnosed was known; in other words, whether the OA was explained or unexplained (further details will be presented in chapter VII). *It is to be noted that patients with glaucoma were not included.*

In the patients of the retrospective study, function tests other than those concerning visual acuity (e.g. visual fields and colour vision) were rarely if ever performed. In a large number of patients with an optic neuropathy it was therefore impossible to apply the definition of OA given in section II-4 on the basis of the data from the records. In the retrospective study therefore, a patient was considered to suffer from OA or to be an OA suspect if this diagnosis was mentioned in the case record or if the description of the fundal features showed that this was meant, even if no mention was made of a distinct decrease in visual acuity. In the field study to be discussed later, optic nerve functions other than visual acuity were also considered; the relevant passages will show that visual acuity can be quite adequate in the presence of visual field defects and colour vision defects.

a. Division into groups

The material thus obtained was divided into four groups:

I. Bilateral unexplained OA

In these cases there was ophthalmoscopic evidence of unmistakable temporal or total atrophy of the optic disc, the cause of which remained obscure.

II. Bilateral suspected OA

In these cases the ophthalmoscopic features were not so pronounced as to be conclusive of a pathological condition. This group exclusively comprises patients for whose OA (if any) no explanation could be traced.

III. Unilateral unexplained OA (suspected and evident)

In these cases, the ophthalmoscopic features of one eye were conclusive or suspected of a pathological condition, while the optic disc of the other eye presented a normal appearance. This group, too, exclusively comprises patients with unexplained OA.

IV. Explained OA

This group includes all cases of ophthalmoscopically evident or suspected, bilateral or unilateral OA of demonstrable aetiology.

b. Composition of the entire case material

Our discussion primarily focuses on the group of bilateral unexplained OA and that of bilateral suspected OA. The group of explained OA will be evaluated later.

The MEU and the PP studied a shorter period, covered a smaller area and saw a smaller number of patients than the AH (table V-1).

TABLE V-1. Composition of the case material studied

Records			Unexplained						Explained	
institute	period	total	bilateral		bilateral suspected		unilateral			
AH	1950-1976	3753	2005	53.4%	828	22.1%	286	7.6%	634	16.9%
MEU	1974-1976	144	53	36.8%	51	35.4%	26	18.1%	14	9.7%
PP	1971-1976	430	153	35.6%	164	38.1%	47	10.1%	66	15.3%
Total		4327	2211		1043		359		714	

TABLE V-2. Racial distribution of optic atrophy in the records of the AH over the period 1950-1976

	Number	Bilateral unexplained	Bilateral suspected	Unilateral unexplained	Explained
Creole	2360	58.8%	21.0%	7.6%	12.6%
Bush Negro	441	66.7%	13.6%	6.6%	13.1%
Hindustani	830	36.0%	29.4%	8.1%	26.5%
Javanese*	89	16.8%	23.6%	9.0%	50.6%
Chinese*	12	41.7%	8.3%	8.3%	41.7%
Indians*	17	17.6%	35.3%	5.9%	41.2%
Others*	4	50.0%	0 %	25.0%	25.0%
Total	3753				

* In subsequent tables these groups, of such small numbers, are no longer mentioned separately but lumped under the heading 'others'.

TABLE V-3. Sex distribution of optic atrophy by ethnic group in the records of the AH

	Bilateral unexplained	Bilateral suspected	Unilateral unexplained	Explained	Total number
MALES					
Creole	60.2%	17.1%	7.4%	15.3%	1198
Bush Negro	69.1%	11.4%	5.2%	14.3%	308
Hindustani	35.3%	25.6%	9.4%	29.7%	360
Others	19.4%	27.8%	7.0%	45.8%	72
FEMALES					
Creole	57.3%	25.1%	7.7%	9.9%	1162
Bush Negro	61.0%	18.7%	9.8%	10.5%	133
Hindustani	36.6%	32.3%	7.1%	24.0%	470
Others	22.0%	16.0%	12.0%	50.0%	50

The epidemiological statistical considerations therefore focus exclusively on the case material of the AH (tables V-2, V-3 and V-4).

c. Racial, sex and age distribution of optic atrophy

Table V-4 shows that the frequency of occurrence of the various types of OA in the various age categories is not markedly different in males and females; it therefore seems unnecessary to study differences in frequency of occurrence of OA between the ethnic groups separately in males and females.

TABLE V-4. Sex, age and racial distribution of optic atrophy (relative frequencies in %)

	Creole				Bush Negro				Hindustani				Others			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Age																
Male		N = 1183				N = 272				N = 349				N = 71		
0-9	0.6	2.9	2.2	5.6	1.6	0.0	0.0	5.0	0.8	4.3	0.0	9.9	7.1	0.0	0.0	3.1
10-19	6.3	6.9	6.7	8.4	11.6	14.3	7.1	10.0	7.3	7.6	3.1	10.9	7.1	10.0	0.0	18.8
20-29	16.6	16.2	11.2	12.8	13.2	3.6	0.0	15.0	14.5	14.1	3.1	17.8	28.6	25.0	20.0	21.9
30-39	18.1	14.2	9.0	17.3	19.5	25.0	7.1	20.0	15.3	13.0	21.9	22.8	21.4	15.0	20.0	6.3
40-49	18.8	25.0	13.5	16.8	21.1	25.0	7.1	22.5	25.8	25.0	15.6	11.9	21.4	20.0	20.0	15.6
50-59	16.3	17.2	15.7	17.9	13.2	10.7	28.6	15.0	14.5	17.4	21.9	9.9	7.1	10.0	20.0	12.5
60-69	13.9	8.3	20.2	10.6	12.6	10.7	28.6	10.0	14.5	13.0	6.3	8.9	0.0	10.0	0.0	12.5
70 and over	9.3	9.3	21.3	10.6	7.4	10.7	21.4	2.5	7.3	5.4	28.1	7.9	7.1	10.0	20.0	9.4
Female		N = 1153				N = 114				N = 462				N = 45		
0- 9	0.8	0.7	2.2	5.4	0.0	0.0	0.0	7.7	0.0	1.4	0.0	11.9	0.0	12.5	0.0	17.4
10-19	7.5	6.9	6.7	8.0	16.4	22.2	0.0	23.1	7.6	4.1	6.1	15.6	12.5	0.0	12.5	17.4
20-29	11.8	12.1	5.6	12.5	19.2	11.1	10.0	0.0	12.2	14.9	18.2	19.3	0.0	0.0	12.5	8.7
30-39	16.3	19.0	10.1	17.9	17.8	22.2	30.0	23.1	27.3	24.3	18.2	16.5	25.0	33.3	37.5	17.4
40-49	24.1	23.9	12.4	17.9	20.5	16.7	10.0	23.1	27.3	30.4	24.2	15.6	25.0	33.3	0.0	8.7
50-59	17.2	14.5	13.5	16.1	11.0	16.7	20.0	23.1	13.4	15.5	18.2	9.2	25.0	16.7	12.5	13.0
60-69	13.6	13.5	19.1	8.0	9.6	11.1	10.0	0.0	11.0	6.1	15.2	9.2	12.5	0.0	12.5	8.7
70 and over	8.7	9.3	30.3	14.3	5.5	0.0	20.0	0.0	1.2	3.4	0.0	2.8	0.0	0.0	16.7	8.7

I = bilateral unexplained
II = bilateral suspected
III = unilateral unexplained
IV = explained

2. Incidence of optic atrophy in relation to chronological time, age, district of origin and ethnic origin

First of all, a measure should be defined in which the frequency of occurrence of OA can be expressed.

a. Annual incidence rate

The annual incidence rate (IR) of OA is defined as the number of persons in whom OA might for the first time be diagnosed in the course of a defined period (of one year), divided by the mean size of the population considered during this period.

Since the study in question considered only the passive incidence among those who presented themselves at the AH, a measure suitable for this study has to be introduced.

b. Hospital incidence rate

The hospital incidence rate (HIR) of OA is defined as the number of persons in whom, according to the records of the AH, OA was diagnosed for the first time in the course of a defined period, divided by the mean size of the population considered during this period, multiplied by the duration of the period in years.

HIR/IR is called the hospital selection rate (s) for the population considered during the period defined. This variable can be interpreted as a measure of that proportion of the OA present in a given population that is known as such at the out-patient clinic of the AH.

The following equation can now be formulated:
if, during a defined period,
N = the mean size of the population considered,
n = the number of not previously registered patients with OA in this population,
o = the number of OA patients in this population registered for the first time at the AH,
d = the duration of that period in years, and
s = the hospital selection rate,
then:

$$IR = \frac{n}{Nxd}$$

$$HIR = \frac{o}{Nxd} = \frac{n}{Nxd} \cdot \frac{o}{n} = IR.s$$

Note: The tables always list 100,000 HIR instead of HIR, i.e. the annual number of OA patients registered for the first time per 100,000 persons of the population considered.

It is shown in table V2 and in section V2c that the incidence of OA in Javanese, Chinese, American Indians and others is low. I shall therefore confine myself henceforth to Creoles and Hindustani.

Comparison of the IR of OA in Creoles with that in Hindustani on the base of the data collected is possible only if:

$$\frac{HIR\ (creole)}{HIR\ (hindu)} = \frac{IR\ (creole)}{IR\ (hindu)}$$

that is to say: if the hospital selection rate (s) for the Creole population considered always equals that for the corresponding Hindu population.

Since s may be highly dependent on chronological time, the age of OA patients and the district of origin, the total case material will be divided according to these factors for comparison of the frequency of OA in Creoles with that in Hindustani. Since census data are required for calculation of the HIR, the division according to these factors is so made that census information is available for the groups thus defined. The census data of 1921, 1950, 1963 and 1971 were available to us (table V-4a).

TABLE V-4a. Ethnic groups in the population on 31st December

Ethnic groups	1921			1950			1963			1971		
	m	v	t	m	v	t	m	v	t	m	v	t
Creole	26.3	29.5	55.8	35.2	39.9	75.1	55.6	58.3	113.9	58.5	60.0	118.5
Hindustani	17.3	13.6	30.9	33.0	31.1	64.1	56.2	55.2	111.4	72.0	70.3	142.3
Indonesian	10.9	7.9	18.8	17.8	17.3	36.1	24.5	23.5	48.0	29.8	29.1	58.9
Chinese							3.0	2.3	5.3	3.5	2.9	6.4
Indian							3.6	3.6	7.2	5.2	5.0	10.2
European							2.2	2.1	4.3	2.2	1.8	4.0
Bush Negro							13.5	14.0	27.5	18.7	20.8	39.5
Others	4.2	2.6	6.8	4.6	4.0	8.6	1.5	1.4	2.9	2.6	2.5	5.1
Unknown				0.3	0.1	0.4	0.3	0.2	0.5			
Total	58.8	53.6	112.3	91.5	92.2	184.7	160.4	160.6	321.0	192.5	192.4	384.9

For 1950 and 1963, no separate data per district are available. This is why, for the period for which these years supplied the mean population size, only a division into two age groups was made:

15 years and under
over 15 years.

The population size in each of the three census figures for each of the ethnic groups, is known for these two classes. The 1950 census data, always multiplied by factor

$$\frac{205.6}{184.7} = \frac{\text{pop. } 1953}{\text{pop. } 1950}$$

are used as mean for the period 1950-1956, the 1963 census data as mean for the period 1961-1965, and the 1971 census data as mean for the period 1968-1974.*

The influence of chronological time on the HIR was evaluated on the basis of possible differences between these periods. For 1971, population data by district of origin and a more detailed age distribution are available.

c. Hospital incidence rate in chronological time

For the period described in the preceding subsection, table V-5 (A) presents a survey of the HIR of the three groups of OA (OA, suspected OA and explained OA) registered for the first time at the AH, considered separately for the two age groups '15 years and under' and 'over 15 years' (the data obtained in the censuses of 1950 and 1963 were only divided according to these two age groups) in each of the four ethnic groups: Creoles, Bush Negroes, Hindustani and others. The focus will be mostly on age group 'over 15 years'.

* The annual number of registered OA patients per population group per subdivision is fairly small. We therefore prefer an analysis based on periods of suitable duration. The year 1971 could also have been accepted as mean for the period 1966-1976 (thus encompassing all AH information). This was not done because there was a strong suspicion that OA was diagnosed on the basis of different criteria during the period 1966-1967 (see chapter VII).

TABLE V-5. Hospital incidence rate (HIR) of three categories of optic atrophy in relation to chronological time, separately per race and age group

Period	Bilateral OA unexplained				Bilateral OA suspected				Explained OA			
	C	B	H	O	C	B	H	O	C	B	H	O
1950-1956												
15 and under	16.3	3.2	1.2	0	2.1	0	1.2	0.9	8.5	0	3.3	1.8
over 15	303.0	48.7	26.5	2.5	40.1	4.0	6.8	1.5	56.6	10.7	28.2	8.4
1961-1965												
15 and under	1.5	7.3	0.7	0.7	2.9	1.8	0.7	0.7	1.5	0	1.0	1.4
over 15	79.6	42.5	10.1	0.5	37.8	11.6	21.1	3.8	11.1	7.7	8.6	2.7
1968-1974												
15 and under	1.1	10.5	0.4	0	0.3	2.3	0.6	0	2.1	3.5	2.3	0.8
over 15	32.1	70.0	9.2	0.6	21.0	13.7	10.8	0.6	10.0	11.0	9.6	2.7
1950-1956												
15 and under	13.6	2.7			1.8	0			2.6	0		
over 15	14.4	1.8			5.9	0.6			2.0	0.4		
1961-1965												
15 and under	2.1	10.4			4.1	2.6			1.5	0		
over 15	7.9	4.2			1.8	0.5			1.3	0.9		
1968-1974												
15 and under	2.7	26.2			0.5	3.8			0.9	1.5		
over 15	3.5	7.6			1.9	1.3			1.0	1.2		

A: HIR in relation to chronological time

B: ratio HIR(C):HIR(H) and HIR(B):HIR(H)

C = Creole B = Bush Negro H = Hindustani O = Others

The HIR of bilateral unexplained OA in Creoles diminishes in the course of the years. In Hindustani, the decrease during the first period is far less marked. From 1963 on, the HIR in this population group remains virtually constant. In Bush Negroes the HIR increases. Suspected OA shows a similar trend in Creoles and Bush Negroes.

The explained OA category shows a marked decrease in HIR both in Creoles and in Hindustani op to 1963; it remains virtually constant after 1963. In the Bush Negroes, this HIR remains virtually constant throughout the period studied.

For the category 'Others' (including Javanese, Chinese and In-

dians), the HIR of all types of OA is very low. During the period 1950-1976, the mean annual presentation of OA at the AH was only one case for this group, versus 50 cases in Creoles, 10 in Hindustani and 10 in Bush Negroes (table V-6).

TABLE V-6. Annual number of cases of unexplained atrophy, averaged over the period 1950-1976

Group	Greole	Hindustani	Bush Negro	Others
I	50	10	10	1
II	18	9	2	1
III	11	8	2	2

The ratio of the incidences of the various optic neuropathies between Creoles and Bush Negroes on the one hand, and Hindustani on the other, can under certain conditions (see section V-2b) be reflected in the ratio between the corresponding HIRs. Table V-5 (B) mentions the ratio HIR/HIR (hindust.). In the group 'Others', which is not included in the table, the ratio is 0.1.

This shows that, in the group over 15 years, the IR of bilateral unexplained OA in Creoles was 3.5 times as high as that in Hindustani towards the end of the period studied, while that in Bush Negroes was even 7.6 times as high. These differences were far less marked for suspected OA and explained OA.

The situation in the Bush Negroes of group 15 years and under was entirely different (HIR of bilateral unexplained OA 26 times as high as that in Hindustani).

The number of patients in these categories is too small to warrant definite conclusions on the basis of these figures.

It was also found that the HIR of bilateral unexplained OA decreased more rapidly in Creoles than in Hindustani.

d. Optic atrophy in relation to age

It was demonstrated in the preceding subsection that the HIR of OA in group '15 years and under' is low as compared with that in group 'over 15 years'. Since a detailed age distribution of the population is available for 1971, the age-dependence of the OA incidence

TABLE V-7. HIR for three categories of OA in relation to age

Age	I		II		III	
	C/B	H	C/B	H	C/B	H
0- 9	1.0	-	0.3	0.6	1.3	2.5
10-19	7.4	1.1	3.5	1.5	3.5	1.8
20-29	16.6	3.6	7.4	1.5	7.4	4.4
30-39	23.4	5.2	24.6	4.2	6.2	11.4
40-49	63.3	15.6	41.3	28.1	8.3	12.5
50-59	70.3	26.2	29.6	28.9	20.3	21.0
60-69	94.4	42.6	35.1	37.3	18.9	42.6
70-79	114.9	42.5	38.3	56.7	38.3	42.5
80 and over	74.6	84.0	32.0	126.1	64.0	-

A: HIR per age class

0- 9	-	0.5	0.5
10-19	6.7	2.3	1.9
20-29	4.6	4.9	1.7
30-39	4.5	5.8	0.5
40-49	4.1	1.5	0.7
50-59	2.7	1.0	1.0
60-69	2.2	0.9	0.4
70-79	2.7	0.7	0.9
80 and over	0.9	0.3	-
mean ratio	3.2	2.0	0.8

B: ratio HIR(C/B):HIR(H)

C/B = Creole and Bush Negro
H = Hindustani

can be studied on the basis of the total case material over the period 1968-1974, and the Creole/Hindustani ratio of incidence can be calculated. However, the data on 1971 lump Creoles and Bush Negroes under one heading. In this subsection and the following, therefore, OA patients among Creoles and Bush Negroes will likewise be lumped under the single heading 'Creole/Bush Negro'. The age-dependent incidence of OA in this group is then compared with that in the group Hindustani.

Table V-7 (A and B) shows that bilateral unexplained OA is significant-

ly more common in Creoles than in Hindustani in all age categories except that over 80. The difference averaged a factor 3.2. Another striking finding is that both Creoles and Hindustani show a relatively marked increase in bilateral unexplained OA around age 40. *In the group bilateral suspected OA, the category Creole/Bush Negro is overrepresented as compared with the Hindustani group until age 40* (HIR Cr/BN: HIR Hind averages 3.4). The ratio after age 40 is virtually 1:1. In the group explained OA, there are no marked general differences between Creoles, Bush Negroes and Hindustani.

Since the incidence of the various optic neuropathies was found to be relatively low under age 15, and since a change in the incidence of the various optic neuropathies was observed around age 40, another division was made: into age group 1 through 15, age group 16 through 39 and age group 40 and over. The HIRs and ratios for these age groups are presented in table V-8.

TABLE V-8. HIR of three categories of OA in relation to three age groups

Age group	I		II		IV	
	C/B	H	C/B	H	C/B	H
1-15	2.8	0.4	0.7	0.6	2.4	2.3
16-39	13.9	3.1	10.6	2.6	4.5	5.4
40 and over	77.3	25.3	36.1	33.0	19.6	20.7
1-15	7.0		1.2		1.0	
16-39	4.5		4.1		0.8	
40 and over	3.0		1.1		0.9	

A: HIR per age group

B: ratio HIR(C/B):HIR(H)

In all these age groups, bilateral unexplained OA shows an unmistakably higher HIR in the Creole/Bush Negro group than in the Hindustani group. In age group 16-39, suspected OA shows a significantly higher HIR in the Creole/Bush Negro group than in the Hindustani group (difference by factor 4.1), whereas no significant difference is observed in the group under 16 and that over 40 years of age. The three age groups show virtually no difference in explained OA.

TABLE V-10.
A = HIR 1968-1974 for districts Paramaribo and Suriname in the two oldest age groups
B = ratio HIR(C/B):HIR(H) for districts Paramaribo and Suriname in the two oldest age groups

		OA group I						OA group II						OA group IV					
		C/B			H			C/B			H			C/B			H		
		Par	Sur	OD	Par	Sur	OD	Par	Sur	OD	Par	Sur	OD	Par	Sur	OD	Par	Sur	OD
A	16-39	20.4	7.4	12.5	6.6	1.0	4.9	15.7	2.8	12.5	2.7	2.6	2.4	4.7	1.9	6.3	9.3	1.6	10.9
	40 and over	67.1	42.3	137.1	31.7	24.0	22.6	37.9	22.1	48.7	52.9	21.0	39.6	27.1	5.5	21.1	21.1	18.0	25.4
B	16-39	3.1	7.4	2.6	mean 4.4			5.8	1.1	5.2	mean 4.1			0.5	1.2	0.6	mean 0.8		
	40 and over	2.1	1.8	6.1	mean 3.3			0.7	1.1	1.2	mean 1.0			1.3	0.3	0.8	mean 0.8		

Par = Paramaribo (district)
Sur = Suriname (district)
OD = all other districts

C/B = Creole and Bush Negro lumped together
H = Hindustani

I = bilateral unexplained OA
II = bilateral unexplained suspected OA
IV = explained OA

Table V-11 presents HIRs in age group 40 and over for the various districts. Relatively few Creoles live in the district Suriname, while the districts Para, Marowijne and Coronie have relatively small Hindustani populations.

TABLE V-11. HIR of bilateral unexplained OA over the period 1968-1974, in age_group 40 and over, per district

District	HIR(C/B)	HIR(H)
Paramaribo	67.1	31.7
Suriname	42.3	24.0
Para	257.5	–
Coronie	74.6	–
Saramacca	332.2	14.0
Commewijne	–	–
Nickerie	11.5	20.1
Marowijne	189.1	–
Brokopondo	42.8	–

In the district Para, where the Creole/Bush Negro population group is distinctly predominant, the HIR of 257.5 indicates that, in this district, 3 out of 1000 inhabitants per year are newly registered as suffering from bilateral unexplained OA.

3. Asthenopia and selection rate

The above described variations in OA incidence between the various ethnic groups can be an expression of real differences in the incidence of this pathology between the various population groups. On the other hand, they may be an expression of artefacts.

In an effort to establish whether or not the various population groups differed in supply of patients, the HIR of asthenopia was determined. Between 1950 and 1976, the ophthalmologists of the ophthalmological out-patient clinic of the AH in Paramaribo diagnosed asthenopia in all cases in which eye complaints were expressed but no lesions found - a phenomenon which is quite common in Suriname. If any of the population groups should show a more marked tendency to visit the ophthalmological out-patient clinic with any complaint whatever (including asthenopia), then this should become apparent in the HIR of asthenopia.

For example, if the hospital selection rate of Creoles with OA is higher than that of Hindustani with OA, then the HIR of asthenopia should be higher in Creoles than in Hindustani.

For the years 1953, 1963 and 1971, the number of cases of asthenopia registered in the records of the AH was considered (table V-12).

TABLE V-12. Registered cases of asthenopia and HIR of asthenopia

Number of cases registered in:	Creole/ Bush Negro	Hindustani	Others
1953	133	49	24
1963	718	425	75
1971	762	569	147
HIR in:			
1953	291	146	36
1963	960	832	201
1971	1016	829	258

The HIR of asthenopia was obtained by dividing the number of cases registered by the number of units of 100,000 in the population of 15 years and over.

This table shows the following:

A marked increase in asthenopia registrations until 1963, but hardly any further increase after 1963.

From 1963 on, relatively little more cases of asthenopia are registered in Creoles than in Hindustani, the ratio being 12:10 (much lower than the ratio in HIR of OA).

Far fewer cases of asthenopia are registered in Javanese, Chinese and Indians (group 'Others') than in Creoles and Hindustani.

We may therefore assume that the differences in OA found between Creoles/Bush Negroes and Hindustani - at least over the period after 1963 - are not based on a difference in hospital selection rate.

4. Summary of epidemiological findings

This chapter discussed the indicence rate (IR) of various defined

groups of OA in relation to sex, chronological time, age, ethnic origin and district of origin. The following findings were obtained:

There was no significant difference in the incidence of optic atrophy between males and females.

The IR of bilateral unexplained optic atrophy diminished in the course of time in the Creoles, increased in the Bush Negroes, and remained virtually unchanged after 1963 in the Hindustani.

Bilateral unexplained optic atrophy was found to increase in incidence with increasing age, with a distinct jump (marked increase in incidence) around age 40.

Optic atrophy, and particularly bilateral unexplained optic atrophy, was found more frequently in Creoles and Bush Negroes than in Hindustani, and was very uncommon in the other population groups.

The districts Para and Saramacca were found to show the highest incidence of bilateral unexplained optic atrophy.

EPIDEMIOLOGICAL FINDINGS OBTAINED WITH THE MOBILE EYE UNIT

1. *Population centres considered*

The mobile eye unit (MEU) visited population centres in the districts Commewijne, Saramacca, Suriname, Para and Nickerie during the period 1974 through 1976. Since separate census data on these centres are not available, the data collected by the MEU are not suitable for epidemiological analysis along the lines set forth in chapter V.

This chapter, therefore, presents only a comparison of the data on some centres representative for certain population groups, with the findings outlined in chapter V.

The figures pertaining to the centres listed in table VI-1 were obtained by lumping the data obtained at a number of MEU stops in the region considered.

For Onverwacht we lumped together: Onverwacht, Zanderij and Republiek.
For Mariënburg we lumped together: Mariënburg and Tamanredjo.
For Matta we lumped together: Matta and Bigi Poika.

TABLE VI-1. Patient supply and incidence of the various types of OA in the various racial groups in the various population centres (MEU)

	Onverwacht							*Mariënburg*						
	C	BN	H	J	I	Ch		C	BN	H	J	I	Ch	
group														
I	16	–	–	–	–	–		–	–	–	–	–	–	
II	6	–	–	–	–	–		–	–	2	1	–	–	
III	3	–	1	–	1	–		–	–	2	–	–	–	
IV	–	–	–	–	–	–		–	–	1	–	–	–	
							Tot.							*Tot.*
patient supply	307	4	10	4	21	4	350	14	–	30	156	–	5	205
patient supply in %	87.7	1.1	2.9	1.1	6.0	1.1		6.8	–	14.6	76.1	–	2.5	
number of optic neuropathies	25	–	1	–	1	–	27		–	5	1	–	–	6

TABLE VI-2. Ratio HIR(C):HIR(H) of bilateral unexplained OA (group I) and bilateral suspected OA (group II) in three age groups in the Nickerie district (MEU)

	Age group	Ratio HIR(C): HIR(H)
OA group I	0-15	–
	16-39	11.9
	40 and over	12.0
OA group II	0-15	4.8
	16-39	3.3
	40 and over	3.2

2. Conclusions

The MEU did not visit a single settlement which could be described as representative for Bush Negroes.

The data obtained by the MEU likewise show that the categories bilateral unexplained OA (group I) and bilateral unexplained suspected OA (group II) were significantly more often encountered in Creoles than in Hindustani, and that this optic neuropathy is hardly ever found in Javanese, Indians and Chinese.

The findings of the MEU in the district Nickerie, however, may be more representative than those in other districts, because the Nickerie data pertain to a large group of 2342 patients. These findings are all

Matta							*Nickerie*						
C	BN	H	J	I	Ch		C	BN	H	J	I	Ch	
1	–	–	–	1	–		42	–	9	–	–	–	
–	–	–	–	3	–		24	1	21	6	–	–	
–	–	–	–	1	–		–	–	–	–	–	–	
–	–	–	–	–	–		2	–	9	–	–	–	
						Tot.							*Tot.*
22	–	1	2	165	1	191	625		1350	330	14	23	2342
11.5	–	0.5	1.1	86.4	0.5		26.7		57.6	14.1	0.6	1.0	
1	–	–	–	5	–	6	68	1	39	6	–	–	113

the more striking because the relative Creole and Hindustani patient supplies differ significantly from the corresponding patient supplies in the Academic Hospital (AH) in Paramaribo (city).

In 1971, 26.6% of the MEU patients in Nickerie were Creoles, and 57.6% were Hindustani; the corresponding figures in the AH were 56% and 35%.

Table VI-2 shows that, in age group 16 and over, bilateral unexplained OA was found 12 times as often in Creoles as in Hindustani. In the group of bilateral unexplained suspected OA the ratio was 3.3.

The MEU findings confirm the conclusion in chapter V that bilateral unexplained OA and bilateral suspected OA are significantly more common in the Creole population groups than in the Hindustani, and that the incidence of these conditions is negligible in Javanese, Indians and Chinese.

SYMPTOMATOLOGY AND AETIOLOGY OF THE OPTIC NEUROPATHIES FOUND

1. Explained versus unexplained optic atrophy

The terms explained OA and unexplained OA were introduced in chapter V. A case of OA was interpreted as explained in the following cases.

1. When the history revealed a trauma, disease or intoxication of which we know that it can lead to degeneration of the optic nerve.
2. When neurological disorders were observed in the patient.
3. When the fundus (or fundi) revealed unmistakable evidence of central of peripheral degeneration and/or other retinopathies known to be capable of causing secondary optic atrophy.

These criteria may well be too wide, but I preferred this to an approach in which an optic atrophy might be too readily interpreted as 'unexplained'.

2. Exclusion of the years 1966 and 1967

The annual number of diagnoses of OA made at the out-patient clinic of the AH shows a gradual decrease in the course of the years, although the differences between successive years are small (see chapter V). The years 1966 and 1967 show an exception to this trend in that OA was diagnosed particularly often. During these years (8% of the total period studied), an optic neuropathy was found in 311 Creoles, 207 Hindustani and 44 Bush Negroes. During this period, bilateral unexplained OA was diagnosed in Hindustani in 91 cases, versus a total of 299 cases over the period 1950-1975. This means that Hindustani accounted for 30.4% of the total number of cases with this pathology during a period which was only onetwelfth of the total period studied.

Of these 91 Hindustani, 53 (58.2%) had a visual acuity exceeding 0.8, whereas over all the other years the average number of patients with bilateral unexplained OA and a visual acuity exceeding 0.8 amounted only to 25.5% of the total.

During this period, bilateral unexplained OA was diagnosed in 167 Creoles (12%), and 72 of them (43%) had a visual acuity exceeding 0.8 (versus an average of 29.3% in this category over the years).

These data raise the suspicion that optic discs may have been incorrectly interpreted as atrophic during this period, both in Hindustani and in Creoles. The problem arises from the fact that, in the retrospective study, the definition of optic atrophy given in chapter II could not be applied.

During the period 1950-1975, numerous ophthalmologists worked in succession in the ophthalmological department of the AH. Precisely during 1966 and 1967 one of the ophthalmologists diagnosed an exceptionally large number of cases of optic atrophy.

As in the epidemiological study, the data collected at the AH over the period 1966-1967 will be disregarded in the clinical description of the optic neuropathy. These descriptions focus on the bilateral unexplained OA cases (group I), the bilateral unexplained suspected OA cases (group II) and the explained OA cases (group IV).

3. Frequency of the various types of optic atrophy

To begin with it can be observed that the three racial groups considered all showed a high rate of unexplained OA. (table VII-1). Moreover, there proved to be differences in distribution between Creoles and Bush Negroes on the one hand, and Hindustani on the other. In Creoles and Bush Negroes the difference in frequency between group I and group IV were very marked. In the Creoles and Bush Negroes seen at the AH, group I was found five times as often as group IV; and in the patients seen by the MEU the difference was even factor 20. In Hindustani, group I and group IV represented virtually the same percentage in the various out-patient clinics.

Group I represented more than 50% of all cases of OA in the Creoles of the AH and the MEU, and 67% of all cases in the Bush Negroes of the AH. It represented a smaller percentage of all cases seen in the private practices (PP).

4. The features of the optic disc

When we consider the features of the optic disc in group I, as ob-

TABLE VII-1. Frequency of the various groups of optic atrophy in three racial groups seen at the AH, in PP and by the MEU

	AH				PP				MEU			
	I	II	IV	tot.	I	II	IV	tot.	I	II	IV	tot.
Creoles	1220 (59.5)	395 (19.2)	275 (13.4)	2049	126 (40.2)	113 (36.1)	36 (11.5)	313	42 (54.5)	24 (31.2)	2 (2.6)	77
Bush Negroes	269 (67.7)	50 (12.6)	53 (13.3)	397	15 (33.3)	21 (46.6)	7 (15.5)	45	0	1 (100)	0	1
Hindustani	208 (33.4)	158 (25.4)	203 (32.6)	623	9 (23.7)	16 (42.1)	8 (21.0)	38	9 (17.3)	21 (40.4)	10 (19.2)	52

I – bilateral unexplained OA
II – bilateral unexplained suspected OA
IV – explained OA

TABLE VII-2. The features of the optic disc in group I.

	AH	PP	MEU
Temporal pallor	75.1%	80.4%	68.8%
Total pallor	24.2%	19.3%	30.3%
(one side suspected)	0.7%	0.3%	0.9%

served at the various out-patient clinics (table VII-2), we find that these percentages do not differ much, despite marked differences in conditions of examination and in the social circumstances of the patients.

Since the AH series is considerably larger than the MEU and PP series, moreover, this chapter confines itself to the data collected at the AH.

Group I

The three racial groups showed virtually the same distribution of the various optic disc features (table VII-3A). In Bush Negroes, total pallor of the disc seemed to be slightly more common and temporal pallor therefore slightly less.

Group II

This diagnosis was made twice as often in Hindustani than in Bush Negroes (table VII-3B).

Group IV

A striking finding is that total pallor of the optic disc was more common in Bush Negroes, and that few optic discs were interpreted as

TABLE VII-3. The features of the optic disc in the various groups of optic atrophy.

		C	B	H	
Group I	temporal pallor	75.1%	70.0%	75.0%	
	total pallor	24.0%	29.2%	22.1%	A
	one side suspected	0.7%	0.7%	2.9%	
Group II	bilateral suspected (% of all patients with optic neuropathy)	19.3%	12.6%	25.4%	B
Group IV	temporal pallor	47.0%	33.9%	34.0%	
	total pallor	29.4%	52.8%	36.1%	
	suspected	13.1%	3.8%	18.2%	C
	one side normal	7.6%	5.6%	10.6%	
	one side uncertain	2.7%	3.8%	1.0%	

C = Creole B = Bush Negro H = Hindustani

suspect (table VII-3C). Moreover, temporal optic disc pallor was recorded significantly more often in Creoles than in Bush Negroes and Hindustani.

5. The features of the retina

Group I

About 90% of cases in the three racial groups showed no retinal lesions. In a by no means negligible percentage of cases (9.2% of Creoles, 7.1% of Bush Negroes and 7.2% of Hindustani), very slight pigment shifts in the macular region were observed (table VII-4).

Group II

The distribution of retinal pathology seemed virtually the same as that in group I.

Group IV

In Hindustani, retinal pathology led least frequently to a diagnosis of 'explained OA'; in Bush Negroes this happened most frequently. Both the Creoles and the Bush Negroes included a fairly large group (10.5% of Creoles and 17.9% of Bush Negroes) with peripheral scars of chorioretinitis; in the Hindustani this group was small (3.7%).

It was assumed that these lesions might explain temporal or total optic atrophy. However, since the scars were often rather small, it is exceedingly improbable that they all could have caused optic atrophy.

If all these cases had nevertheless been interpreted as unexplained, then these figures would have been added to the group I and group II figures, and in that case these groups would have increased relatively much more in Creoles and Bush Negroes than in Hindustani. *The epidemiological differences discussed in chapter V would then have been even more pronounced.*

6. Visual acuity

Visual acuity was recorded for each patient after optimal refraction. Moreover, the features of the media were described and divided into five groups on the basis of the clearness of cornea, lens or vitreous

TABLE VII-4. The features of the retina in the various groups of optic atrophy.

	Group I			Group II			Group IV		
	C	B	H	C	B	H	C	B	H
no abnormalities	89.2%	90.9%	91.8%	91.0%	93.0%	94.0%	57.8%	43.4%	74.9%
not interpretable	1.3%	0.5%	0.2%	1.0%		0.3%	5.1%	3.8%	2.0%
macular degeneration central							14.7%	17.0%	9.4%
chorioretinitis scar peripheral							8.2%	13.2%	6.4%
chorioretinitis scar slight pigment shifts							10.5%	17.9%	3.7%
in the macular region	9.2%	7.1%	7.2%	7.9%	7.0%	5.4%	2.9%	4.7%	3.1%
drusen		0.4%	0.2%				0.7%		0.2%
miscellaneous	0.1%	1.0%	0.5%	0.1%		0.3%			

body. In this evaluation, an estimate was made of the decrease in visual acuity which could be due to the opacity of the media involved. The division made was as follows:

clear	: no abnormality
more or less clear	: visual acuity $\geqslant 0.9$
more or less opaque	: visual acuity 0.5-0.8
opaque	: visual acuity 0.1-0.4
markedly opaque	: visual acuity < 0.1

Group I

Particularly in the group with the lowest visual acuity, there were only few patients whose decreased visual acuity could in part be due to opacity of the media (table VII-5A). In the Bush Negroes, the majority of the group I patients proved to have markedly diminished visual acuity (< 0.1 in 40.3%). In the Creoles this number was smaller (< 0.1 in 23.0%) and in the Hindustani it was smallest (< 0.1 in 16.3%).

When we consider the group with visual acuity 0.5, however, we find that Creoles and Hindustani no longer differ much (51.4% and 50.4%, respectively), but that Bush Negroes are again prominently represented (70.0%).

Group II

The decrease in visual acuity in this category was less marked than

that in group I (table VII-5B) In the group with visual acuity < 0 1, Bush Negroes were again much more prominently represented than Creoles and Hindustani (25 0%, 8 3% and 9 2%, respectively) The group with visual acuity < 0 5 constitited 26 8% of the Creoles, 51 0% of the Bush Negroes and 30 1% of the Hindustani

Although the decrease in visual acuity in group II was generally less marked than that in group I, it was nevertheless found that a substantial number of patients with ophthalmoscopic findings interpreted as bilateral suspected OA showed diminished visual acuity

Group IV

The Bush Negroes were again most prominently represented in the group with the lowest visual acuity (< 0.1 in 45 3%) (table VII-5C) But in the group with visual acuity < 0 5, the differences were much less marked (Creoles 62%, Bush Negroes 73 6% and Hindustani 70 3%)

7 *Further findings*

Apart from the abovementioned parameters, on which nearly all case records contained data, additional clinical or anamnestic data were regularly collected, and separately coded.

Groups I and II

Additional data were available on some 40% of group I patients and 32% of group II patients (addendum 5). Only the parameters of constricted arteries or hypertensive retinopathy and gradual decrease of visual acuity stand out to some extent Information on the course of diminished visual acuity was available only on 146 patients (8 6%) of group I and 36 patients (6 0%) of group II; gradual diminution of visual acuity was present in 91 8% and 97.2% of the cases, respectively

Group IV

This group showed more additional pathology than the two previous groups (addendum 6) Outstanding parameters. severe head injuries and various neurological disorders. Explanations were found mainly in macular degenerations, scars of chorioretinitis, traumatic lesions and various neurological disorders (table VII-6) It is to be

TABLE VII-5. Visual acuity (corrected for cases in which diminished visual acuity can also be due to media opacities) in three racial groups with optic atrophy of group I, II and IV

	C			B			H			
Visual acuity	N	due to media	corrected for media	N	due to media	corrected for media	N	due to media	corrected for media	
< 0.1	566	5	23.0%	220	3	40.3%	68	–	16.3%	A-group I
0.1-0.4	717	24	28.4%	176	16	29.7%	155	13	34.1%	
0.5-0.8	453	32	17.2%	65	9	10.4%	84	5	19.0%	
≧0.9	704	–	28.8%	77	–	14.3%	109	–	26.2%	
explained by media			2.5%			5.2%			4.3%	
< 0.1	68	2	8.3%	25	–	25.0%	33	4	9.2%	B-group II
0.1-0.4	172	26	18.5%	29	3	26.0%	73	7	20.9%	
0.5-0.8	147	15	16.7%	17	2	15.0%	61	7	17.1%	
≧0.9	403	–	51.0%	29	–	29.0%	149	–	47.1%	
explained by media			5.4%			5.0%			6.0%	
< 0.1	162	9	27.8%	53	5	45.3%	81	–	20.6%	C-group IV
0.1-0.4	207	19	34.2%	34	4	28.3%	218	16	49.7%	
0.5-0.8	70	8	11.3%	11	1	9.4%	39	2	9.1%	
≧0.9	111	–	20.7%	8	–	7.5%	68	–	16.7%	
explained by media			6.5%			9.4%			4.4%	

TABLE VII-6. Parameters on the basis of which optic atrophy was interpreted as explained

	C	B	H
Macular degeneration	14.7%	17.0%	9.4%
Central chorioretinitis scar	8.2%	13.2%	6.4%
Peripheral chorioretin. scar	10.5%	17.9%	3.7%
Drusen	0.7%	–	0.2%
Traumatic lesion	12.8%	13.2%	18.2%
Hydrocephalus	3.3%	–	3.0%
Encephalitis	0.7%	3.4%	–
Neurosyphilis	1.8%	1.9%	0.5%
Brain tumour	3.6%	–	10.3%
Toxicosis	1.5%	–	3.9%
Eclampsia	0.7%	–	3.0%
Exophthalmos	–	1.9%	–
Retrobulbar phlegmon	0.4%	–	–
Various neurological disorders	10.2%	3.8%	15.3%
Retrobulbar neuritis	2.5%	–	1.5%
Orbital process	1.5%	–	–
Abundant blood loss	0.4%	–	–
Tapetoretinal degeneration	0.7%	7.5%	1.0%
Miscellaneous	25.8%	20.2%	23.6%

noted in this context that macular degeneration and scars of chorioretinitis rarely give rise to optic atrophy. The Hindustani were found to include a strikingly large group with a brain tumour (10.3%).

The heading 'miscellaneous' largely concerns anamnestic findings, e.g. periods of serious food shortage, serious alcohol abuse, a history of cranial surgery, severe malaria (black-water fever), and occasionally severe illness after an overdose of anthelmintic medication. In some other cases the case record suggested that an explanation had been found but contained no further data (probably because the patient was admitted to another department).

8. Findings at refraction

The visual acuity discussed in the preceding section was always that measured after optimal refraction by retinoscopy. There was no correlation between errors of refraction and the occurrence of any type of optic atrophy.

Positive serology (WR and VDRL) as solitary finding without neurological disorders was not accepted as an explanation of the optic atrophy unless a more specific reaction was observed. This in view of the fact that false positive reactions are quite common in Suriname (Gentle 1962; Menke 1978; Notowicz 1979).

For a very large group of patients, no WR and VDRL records were available. The retrospective study therefore warrants no conclusions about a possible correlation between venereal serology and optic atrophy in Suriname. The problems of venereal serology will be further discussed in chapter VIII.

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CLINICAL FINDINGS OBTAINED IN THE FIELD STUDY

1. Procedure

The retrospective study of the case records was followed by a field study confined to the district Para. One of the reasons for this was that bilateral unexplained optic atrophy was found to be very common in the Creoles of this district (chapter V). Moreover, there were some practical arguments (mentioned in chapter IV) in support of the assumption that a pedigree study would have a fair chance of success only in this district.

The objectives of the field study were:

A more detailed study of the symptomatology (chapter VIII).

An effort to establish whether a hereditary factor was demonstrable (chapter IX).

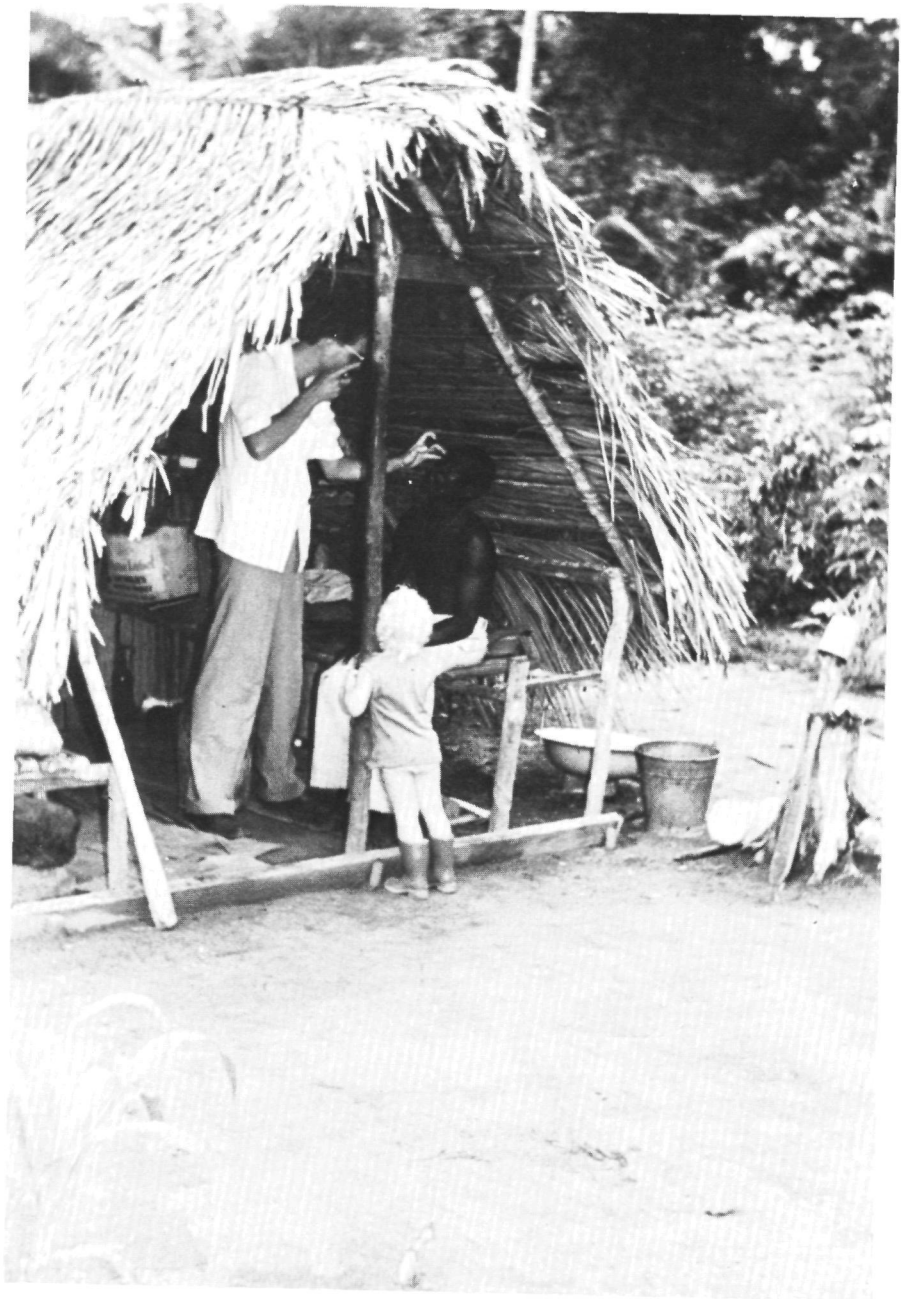
An effort to learn more about the aetiology, in which context nutrition was also evaluated (chapters X and XI).

An analysis of the files on the 4327 patients with optic atrophy revealed that a number of family names came up frequently. All these families originated from plantations in the Para district. Pedigrees of three of these families could be worked out.

Every family member who could be traced was examined ophthalmoscopically. Moreover, a random group of optic atrophy patients from this district were traced who had recently been seen at the AH, in a PP or by the MEU.

The preliminary ophthalmoscopic examination was made under unfavourable conditions (usually in a corner of a cabin, as shown in fig. VIII-1). In the case of suspected pallor of the optic disc, therefore, the patients in question were taken to an examining-room established in the centre of the district. Here, ophthalmoscopy was repeated under mydriasis. If the disc proved in fact to be ophthalmoscopically abnormal, a more extensive examination followed (addendum 2).

This examination required an average of 10 hours per patient (including perimetry in Paramaribo city). A total of 64 patients were thus examined. The group of 'random' patients will be considered separately from this elicited by the pedigree study.



Ophthalmoscopy was performed three times in most cases (at home, in the district examining-room and after perimetry in Paramaribo city). In this way, ten patients were eliminated because it was found that after all they had no pale discs. In most of these ten cases there was a very large physiological cup, or a disc which still proved to show a pink, vascularized temporal zone. Yet in these cases the entire examination was completed, if possible, so that the findings could be compared with those in patients whose optic disc did show distinct pallor.

In six patients the pallor of the optic disc (POD) was interpreted as explained by:

patient E1: macular degeneration
patient E2: glaucoma
patient E3: syphilis (diagnosed 10 years previously, also on the basis of clinical criteria)
patient E4: glaucoma
patient E5: extensive chorioretinitis scars in the posterior pole
patient E6: severe brain injury.

2. *Groups of patients considered*

Group A: random patients with bilateral unexplained POD, who in 1977 could be traced from the 1974 records of the MEU.
Group B: patients with bilateral unexplained POD encountered in the family study.
Group C: patients with suspected POD encountered in the family study.
Group D: patients without evidence of optic neuropathy.
Group E: patients with explained POD.

3. *The features of the optic disc*

Table VIII-1 shows that, as in the retrospective study, most cases involved bilateral unexplained temporal POD. The percentage of patients with bilateral suspected POD in group B was larger than that found in the retrospective study (see table VII-3). This is because these patients were traced in an active study of the population considered (family).

TABLE VIII-1. Distribution of optic disc features (number of eyes)

	Random patients		Family study patients	
	unexplained	explained	unexplained	explained
Bilateral temporal POD	21 (65.6%)	2 (33.3%)	28 (80.0%)	5
Bilateral total POD	8 (25.0%)	4 (66.7%)	5 (14.3%)	0
Unilateral suspected POD (with contralateral POD)	3 (9.4%)	0	2 (5.7%)	0
Total	32	6	35	5
Unilateral POD	0	0	0	1
Bilateral suspected POD (% of unexplained optic neuropathies)	0	0	22 (38.6%)	0
No abnormalities	0	0	24	
Not interpretable	0	0	3	0

4. The features of the retina

In the groups with unexplained and suspected POD. the percentages of patients without any retinal changes were smaller than those in the corresponding groups in the retrospective study (table VIII-2). The percentage of patients with slight pigment changes in the macular region, was much larger than that in the retrospective study.

The differences are probably due to the fact that a more intensive search for slight retinal changes was made in the field study. Substantially fewer retinal changes were found in the group without POD; the only changes found were constricted arteries.

5. Visual acuity

The data presented in table VIII-3 can be compared with the findings obtained in Creoles as shown in table VII-7A of the retrospective study (chapter VII).

The distribution in terms of visual acuity was again very similar to that in the retrospective study. Visual acuity in group B was generally slightly higher than that in group A, because the group A patients had presented at the out-patient clinic with eye complaints, while the ma-

TABLE VIII-2. Distribution of retinal features (number of eyes)

	A	B	C	D	E
No abnormalities	10 (31.2%)	18 (47.4%)	17 (77.3%)	22 (91.7%)	1 (8.3%)
Macular degeneration	0	0	0	0	1 (8.3%)
Slight pigment changes in macular region	16 (50.0%)	8 (21.0%)	0	0	3 (25.0%)
Constricted arteries	16 (50.0%)	11 (28.9%)	4 (23.5%)	2 (8.3%)	10 (83.3%)
Peripapillary pigment changes	8 (25.0%)	6 (15.8%)	0	0	2 (16.6%)
Marked sclerosis of choroidea	0	2	0	0	0
Not interpretable	0	2	0	0	0
Prosthesis (posttraumatic)	0	1	0	0	0
Chorioretinitis scars	0	0	1	0	8 (66.6%)
Occluded venous branch	0	0	0	0	1
Total (of 128 eyes)	32	38	22	24	12

A = random patients with bilateral unexplained POD
B = family study patients with bilateral unexplained POD
C = persons suspected of POD
D = no optic neuropathy
E = explained POD

TABLE VIII-3. Distribution of visual acuities (number of eyes)

	A	B	C	D	E
< 0.1	11 (34.4%)	9 (23.7%)	0	2 (8.3%)	2 (16.7%)
0.1-0.4	6 (18.7%)	6 (15.8%)	2 (9.1%)	0	5 (41.7%)
0.5-0.8	9 (28.1%)	10 (26.3%)	3 (13.6%)	4 (16.7%)	4 (33.3%)
$\geqslant 0.9$	6 (18.8%)	12 (31.6%)	17 (77.3%)	18 (75.0%)	1 (8.3%)
not interpretable		1 (2.6%)			
Total	32	38	22	24	12

jority of group B patients had not. With the exception of two eyes in group D, the decrease in visual acuity was never explained by media opacity.

In this field study, there was no demonstrable difference in visual acuity between the patients with suspected POD and the persons without evidence of optic neuropathy.

6. *Visual fields*

The difficulty in the study of visual fields was that our old Goldmann perimeter could not be properly standardized. We did adjust the contrast of the object against the background prior to each perimetry. In the standard situation described in the directions for use, the luminance with the largest object was 715 Lux.

The visual fields were measured in 10 persons without eye abnormalities aged 18-32, and in a group aged 40-50 thus obtaining an 'average' visual field for normal persons in Suriname with this perimeter. The only difference between the older and the younger age group was that the middle-aged persons occasionally did not properly see the I-1 object. On this perimeter this object was indeed very weak (weaker than it should be on a properly standardized perimeter). In any case, the perimetric findings thus obtained in the patients have significance as

TABLE VIII-4. Distribution of visual field effects, absolute and in percentual relation to the number of eyes examined per group

	A	B	C	D	E
Decreased general sensitivity	19 (95.0%)	22 (64.1%)	6 (37.5%)	1 (7.1%)	7 (70.0%)
Absolute central scotoma	0	3 (8.8%)	0	0	1 (10.0%)
Relative central scotoma	2 (10.0%)	3 (8.8%)	0	0	5 (50.0%)
Absolute paracentral scotoma	5 (25.0%)	4 (11.8%)	0	0	0
Relative paracentral scotoma	2 (10.0%)	8 (23.5%)	2 (12.5%)	0	1 (10.0%)
Centrocaecal scotoma	0	4 (11.8%)	0	0	3 (30.0%)
Enlarged blind spot	6 (30.0%)	16 (47.0%)	4 (25.0%)	1 (7.1%)	5 (50.0%)
Peripheral limitation	12 (60.0%)	12 (35.3%)	4 (25.0%)	2 (14.3%)	6 (60.0%)
Normal	1 (5.0%)	0	4 (25.0%)	10 (71.4%)	0
Not determined	12 (37.5%)	4 (10.5%)	6 (27.3%)	10 (41.7%)	2 (16.7%)

relative measurement in relation to normal values; and, unless too subtle changes are involved, they also have absolute significance.

Visual field defects were found in a large percentage of the eyes examined (table VIII-4). Of the eyes with suspected POD, 75% had visual field defects. However, in the eyes in which the disc was afterwards interpreted as not pathological, slight visual field defects were also found in 28% (slightly decreased general sensitivity, enlarged blind spot and some peripheral limitation, but never scotomas). This group, however, consisted of only 14 eyes examined. A few commonly found visual field defects are shown in fig. VIII-2.

The visual field defects in bilateral unexplained POD proved to be widely variable. An absolute central or a centrocaecal scotoma was rarely found. The most frequent finding was a combination of decreased general sensitivity with paracentral or central absolute and/or relative scotomas, more or less marked peripheral limitation and an enlarged blind spot.

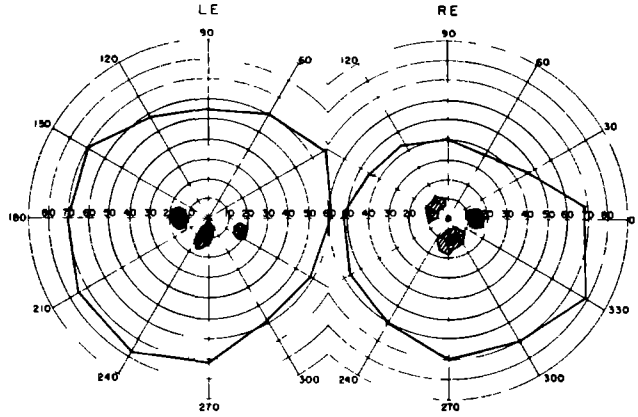
7. Pupillary reactions

Distinct asymmetrical abnormalities in pupillary reaction were seen in only one patient in group A (unilateral seclusio pupillae) and one patient in the group of explained optic atrophy (unilateral macular hole) (table VIII-5). In a few cases, however, the pupillary reaction was very slow, with some light-near dissociation but without miosis. In a few other cases, very marked symmetrical escape was noted (much more marked than in the case of normal hippus). Since these cases always involved bilateral optic neuropathy, no asymmetrical swinging-flashlight phenomenon was observed.

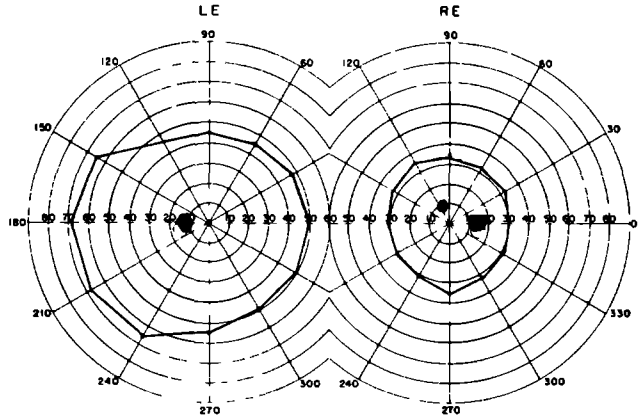
TABLE VIII-5. Pupillary reactions, absolute and in percentual relation to the number of patients examined

	Normal	Slow	Some pupillary escape	Swinging flashlight phenomenon
Group A	11 (68.7%)	4 (25.0%)	3 (18.7%)	0 (seclusio 1 [5.3%])
Group B	17 (89.5%)	0	1 (5.3%)	0
Group C	10 (90.9%)	0	1 (9.1%)	0
Group D	12 (100.0%)	0	0	0
Group E	3 (50.0%)	2 (33.3%)	0	1 (16.7%)

patient A2.



patient A1.



patient A11.

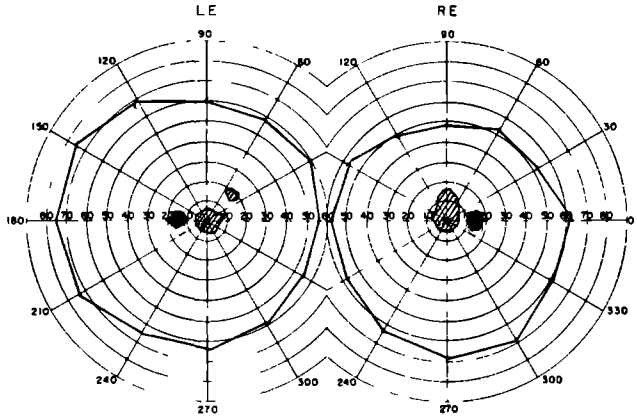
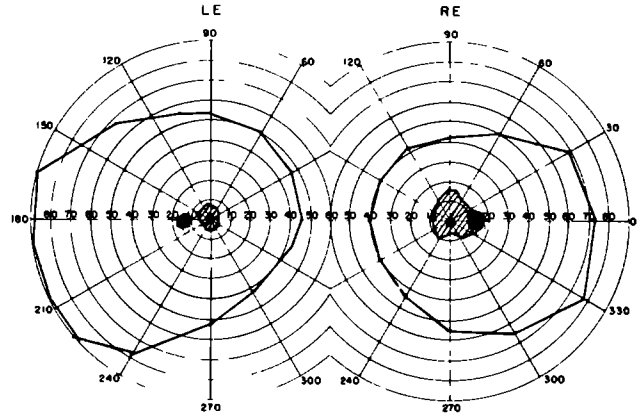
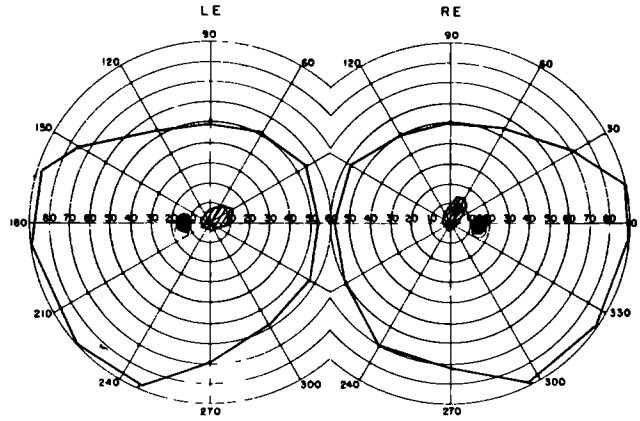


FIG. VIII-2: Some commonly found visual field defects in patients with bilateral unexplained pale optic discs.

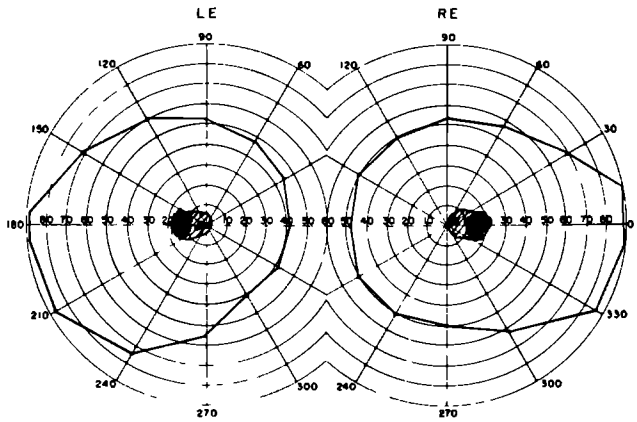
patient B18.



patient B16.



patient B15.



bilateral optic neuropathy, no asymmetrical swinging-flashlight phenomenon was observed.

Both a slow pupillary reaction and pupillary escape are suggestive of disturbed afferent conduction (chapter II).

8. Intraocular pressure

In the group with suspected POD and that with normal optic discs, intraocular pressure was not lower than that in the group with unex-

TABLE VIII-6. Distribution of intraocular pressures (number of eyes)

	A	B	C	D	E
10-14 mm Hg	18	20	12	5	5
15-19 mm Hg	12	15	6	13	3
20-24 mm Hg	0	0	2	0	0
≧25 mm Hg	0	1	0	0	4
not determined	2	2	2	6	0

plained POD (table VIII-6). Although only incidental determinations were involved, these patients with unexplained POD seemed to be free from increased intraocular pressure. However, this does not exclude increased sensitivity of the optic disc to a given intraocular pressure. The group with explained POD includes four eyes with glaucoma.

*9. Colour vision**

Colour vision was examined in as many patients as possible in the field study. As in perimetry, a certain cooperation on the part of the patient is required (and this was not given by every patient).

Use was made of the American Optical Hardy-Rand-Rittler (AO H-R-R) test and a Panel D-15 test. This Panel D-15 test was made up from the hues of the Farnsworth 100-Hue test available in Paramaribo city, by a method described by Pinckers (1971b) and later confirmed to be valid by Higgins and Knoblauch (1977).

* I am deeply indebted to dr. A.J.L.G. Pinckers for his help in analysing the colour vision tests, and his advices in the pedigree studies (chapter IX).

In this way, data were obtained on 61 patients, including 47 in whom each eye was examined separately. The conditions of examination were standardized in that all examinations were made on a porch facing north, between 1400 and 1700 hrs.

The results to be discussed were obtained in the five groups A, B, C, D and E (section VIII-2). The colour vision test results were coded in accordance with the system elaborated in 1957 by François and Verriest, and later supplemented by Pinckers (1971a) (addendum 3).

a. AO H-R-R test

The findings obtained with the aid of the AO H-R-R test are presented in table VIII-7A. Since it has been found that the screening plate 3 of this test can give a false positive result (Pinckers, personal communication), the percentages were corrected accordingly.

Group A and B include a considerable percentage of eyes with disturbed colour vision.

In group A, not a single eye showed a pure diagnostic blue-yellow defect. In this group, 13.6% of the eyes examined only showed a (diagnostic) red-green defect, while 27.3% showed a combination of a red-green with a blue-yellow defect.

Group B included one eye showing only a blue-yellow defect, while 13.8% of eyes showed only a red-green defect. The combination of a red-green with a blue-yellow defect was not seen in this group.

In group C the screening plates revealed as many blue-yellow as red-green defects, while only one diagnostic red-green defect was found.

In group D, neither the screening plates nor the diagnostic plates revealed colour vision defects.

In group E, half of the patients examined (3 out of 6) showed a diagnostic red-green defect.

Since both group A and group B included a large percentage of eyes with a blue-yellow defect according to the AO H-R-R screening plates, we compared these findings with those obtained in the Department of Ophthalmology, University of Nijmegen, in patients with a diagnosis of optic atrophy (table VIII-7B).

The average percentage of blue-yellow defects according to AO H-R-R screening plates in groups A, B and E hardly differed from that in the Nijmegen group (45.6% versus 44.8%). The number of

TABLE VIII-7. AO H-R-R test results in Suriname (A) and in Nijmegen (B)

	Number of eyes	Blue-yellow defects		Red-green defects				Combined diagnostic blue-yellow and red-green defect	
		screening	diagnostic	screening	plate 3	corrected	diagnostic		
		eyes %	eyes %	eyes %	eyes	%	eyes %	eyes %	
A	22	12 54.5	6 **27.3**	11 50.0	2	40.9	9 **40.9**	6 **27.3**	
B	29	11 37.9	1 **3.4**	16 55.2	5	37.9	4 **13.8**	0 **0**	
C	18	2 11.1	0 **0**	5 27.8	3	11.1	1 **5.5**	0 **0**	A
D	20	0 0	0 **0**	1 5.0	1	0	0 **0**	0 **0**	
E	6	3 50.0	0 **0**	4 66.7	0	66.7	3 **50.0**	0 **0**	
OA	46	18 39.1	11 **23.9**	31 67.4	7	52.2	27 **58.7**		
HOA	29	15 51.1	4 **13.8**	17 58.6	5	41.4	12 **41.4**		B
DAOA	32	15 46.9	7 **21.9**	18 56.2	4	43.7	12 **37.5**		

OA = optic atrophy, not hereditary
HOA = hereditary optic atrophy, not dominant autosomal
DAOA = dominant autosomal optic atrophy

pure diagnostic blue-yellow defects likewise differed little: 1 out of 57 (Suriname) versus 2 out of 107 (Nijmegen).

The Nijmegen material was strictly selected on the basis of several criteria, and on the basis of the above comparative figures it may therefore be assumed that the circumstances during the field study have not led to inexplicably large percentages of colour vision defects as measured with the AO H-R-R test.

b. Farnsworth Panel D-15 test

The findings obtained with the Panel D-15 test are presented in table VIII-8. Since 1//T and 1//T$^+$ can be regarded as a false positive result (Verriest 1964; Vola 1970), the percentages were corrected accordingly.

The percentages of blue-yellow defects found in groups A and B were virtually the same (16.7% and 18.5%, respectively), but the percentage of red-green defects in group A was about three times that in group B. One of these patients (no. 8 of group B) also indicated exclusively a blue-yellow defect in the AO H-R-R test. Combined blue-yellow and red-green defects were not found in these groups.

Group C included only two eyes with a red-green defect, and none with a blue-yellow defect.

No colour vision defects were found in group D.

In group E, about one-third of patients showed a blue-yellow defect, while none had a red-green defect.

Direct comparison of these figures with the AO H-R-R test data is very difficult. Firstly because the tests differ substantially, if only in that the AO H-R-R test covers a visual field of about 8°, whereas the

TABLE VIII-8. Farnsworth Panel D-15 test results

	Number of eyes	Blue-yellow defect		Corrected for 1//T and 1//T$^+$		Red-green defect		Combined blue-yellow and red-green defect
		eyes	%		%	eyes	%	
A	24	5	20.8	4	16.7	5	20.8	0
B	27	8	29.6	5	18.5	2	7.4	0
C	18	2	11.1	0	0	2	11.1	0
D	20	1	5.0	0	0	0	0	0
E	8	5	62.5	3	37.5	0	0	0

Panel D-15 test covers a visual field of about 2°. Secondly because the AO H-R-R test indicated combined red-green and blue-yellow defects in many cases, whereas the Panel D-15 test did not.

10. Conclusions based on colour vision tests

Colour vision defects were absent in the group without optic neuropathies (group D) and virtually absent in the group with suspected POD (group C). In the group of random patients with POD (group A), both tests revealed colour vision defects in a substantial number of patients. Combined red-green and blue-yellow defects were found in a fair number of patients in group A (27.3% of the eyes examined with the AO H-R-R test).

The group of patients of the pedigree study (group B) included fewer eyes with colour vision defects, and there were no combined blue-yellow and red-green defects.

Pure red-green defects occurred both in group A and in group B (13.6% and 13.8%, respectively). One patient (no. 8 in group B) had exclusively a blue-yellow defect both with the AO H-R-R and with the Panel D-15 test.

In the group of patients with explained POD (group E), the AO H-R-R test revealed red-green defects in 3 out of 6 cases, and the Panel D-15 test disclosed blue-yellow defects in 37%. Two (33.3%) of the eyes examined showed a combination of a diagnostic red-green defect in the AO H-R-R test with a blue-yellow defect in the Panel D-15 test.

These findings are based on small numbers. Comparison with the percentages found in the Nijmegen series, however, reveals striking similarities. Consequently it seems justifiable to assigns significance to the findings obtained in Suriname.

11. Age

In the field study as well as in the retrospective study, an unmistakable increase in the number of patients was found after age 40.

The estimated age at onset of eye symptoms was between 30 and 50 in the majority (> 50%) of patients able to recall this (table VIII-9).

TABLE VIII-9. Patients' age (a) and estimated age at onset of eye symptoms (b). Groups A, B and C, males and females together

age	a	b
0- 9	1	0
10-19	3	1
20-29	2	3
30-39	4	7
40-49	11	8
50-59	9	8
60-69	9	1
70-79	6	1
80-89	1	0

12. Venereal serology

Optic atrophy can occur in about 14% of cases of tabes dorsalis (Sachsenweger 1975). Vancea et al. (1960) postulated that, in countries where syphilis is common, over 30% of cases of optic atrophy are explained by it. Every patient with optic neuropathy was submitted to a Wassermann and/or VDRL reaction. If the serology was positive, then the more specific FTA abs. test was performed. The latter was of importance because the reagin reactions can be biologically false

TABLE VIII-10. Venereal serology

	A	B	C	D	E
WR					
not done	5 (31.2%)	16 (84.2%)	10 (90.9%)	11 (91.7%)	5
positive	0	0	0	1 (8.3%)	1
negative	11 (68.8%)	3(15.8%)	1 (9.1%)	0	0
VDRL					
not done	0	0	0	1 (8.3%)	0
positive	1 (6.2%)	1 (5.3%)	1 (9.1%)	1 (8.3%)	2
negative	15 (93.8%)	18 (94.7%)	10 (90.9%)	10 (83.3%)	4
FTA abs.					
not done	15 (93.7%)	18 (94.7%)	10 (90.9%)	11 (91.7%)	4
positive	0	1 (5.3%)	0	1 (8.3%)	2
negative	1 (6.3%)	0	1 (9.1%)	0	0

positive, especially in areas where other chronic non-treponemal infectious diseases (e.g. leprosy and malaria) are also endemic. The serological findings are listed in table VIII-10.

In group A, no positive serology was ultimately found. But the serology was positive in 1 patient (5.3%) of group B, 1 patient (8.3%) of group D and 2 patients (33.3%) of group E. Both the patient in group B and the one in group D had a history of yaws; the group B patient still had the scars of it on the lower legs. The history of one of the two patients with a positive venereal serology in group E showed that he had been treated for syphilis in the past.

13. Anamnestic findings

Group A

Patient 11 had had malaria at age 35 (2 years before the onset of eye symptoms), and at age 55 was involved in a traffic accident which may have caused a vertebral fracture (but without head injury).

Patient 12 had had a complicated parturition (15th pregnancy) at age 44 (4 years before the estimated onset of eye symptoms); no further data could be traced, but severe haemorrhage or eclampsia was excluded.

As regards possible intoxications (the data were always verified via family members), no excessive use of alcohol was observed in this group. Three patients regularly smoked cigarettes (up to 10 daily); one was a pipe smoker. None of them smoked home-grown tobacco.

Group B

Patient 11 had had a severe bout of malaria at age 49 (10 years before the onset of eye symptoms). One patient (patient 7) suffered from maturity-onset diabetes mellitus which required only dieting. Patient 12 had a childhood history of yaws. Patient 18 developed (at age 30-35, about 25 years before the onset of eye symptoms) neurological symptoms such as a certain loss of control over the legs, tingling sensations and 'numbness' of the feet (see section VIII.15).

Two patients were regular drinkers when examined (1 l beer daily and 1 l whisky daily, respectively). Patient 17 drank 4 l beer per day and smoked 25 cigarettes per day until 1974. Four other patients were regular smokers (3 smoked about 10 cigarettes per day, and one was a pipe smoker).

Group C

Patient 1 was a pipe smoker, while patients 4 and 6 smoked cigarettes (10 per day and 20 per day, respectively). No further anamnestic particulars were found in this group.

Group D

Patient 3 was hypertensive (RR 160/110) and had had toxaemia of pregnancy at the last parturition at age 38. Three patients smoked about 10 cigarettes daily.

Group E

Patients 2 and 3 had been treated for syphilis in the past. Patient 4 was hypertensive (RR 140/100). Patient 6 had sustained a severe head injury at age 36, with partial facial paralysis as a result (see section VIII.15).

14. Summary of anamnestic findings

In group A there was only one patient in whom a correlation between eye symptoms and a previous disease was indicated (malaria in patient 10). However, visual acuity had not diminished until two years after the malaria.

In group B, no correlation was ever indicated between decreased visual acuity and some other abnormality. One patient had been an excessive drinker and smoker until 2 years before he was examined. One patient indicated vague neurological symptoms which had developed 20 years before the onset of eye symptoms. One patient had a history of a bout of severe malaria, but there was no conspicuous correlation with the eye symptoms.

Group C included one patient who was a more or less heavy smoker (20 cigarettes per day).

In group D, one patient indicated a correlation between parturition and diminution of visual acuity, but there were no distinct ophthalmoscopic changes and visual acuity was not distinctly decreased (VOD 0.8, VOS 1.0, after correction).

All patients in group A, B and C indicated gradual diminution of visual acuity.

TABLE VIII-11. The most common neurological findings

	No abnormality	Conduction hearing loss	Sensorineural hearing loss	Low reflexes	Paraesthesias (tingling sensation in limbs)
A	6 (37.5%)	2 (12.5%)	4 (25.0%)	7 (43.7%)	2 (12.5%)
B	9 (47.4%)	2 (10.5%)	4 (21.0%)	8 (42.1%)	2 (10.5%)
C	10 (90.9%)	0	1 (9.1%)	1 (9.1%)	0
D	11 (91.7%)	0	1 (8.3%)	1 (8.3%)	0
E	3 (50.0%)	1 (16.7%)	1 (16.7%)	2 (33.3%)	1 (16.7%)

15. Neurological examination

All patients with POD and 12 persons without optic neuropathy were submitted to a neurological examination (procedure indicated in addendum 2). The findings are presented in table VIII-11.

No serious neurological disorders were found. Pathological findings were most often obtained in groups A and B, in which arm and leg reflexes were interpreted as too low in 43% and 42% of cases, respectively. Slight sensorineural hearing loss was also most common in these two groups, but was found almost exclusively in elderly patients (> 60), who were probably suffering from presbycusis. In group A as well as in group B, two patients reported paraesthesias (tingling sensations in the hands or feet).

One patient showed facial asymmetry, pulling the mouth to the left when showing his teeth and bulging the right cheek when blowing. The eyes were properly closed, but the history revealed that the right eye had not closed properly in the past. This patient had sustained a head injury at age 36, with subsequent partial recovery from paralysis. The optic neuropathy in this patient was interpreted as explained.

In group B there was one patient with slight distal paresis of the lower legs, involving both the peroneal and the tibial nerve, with some slight loss of sensitivity in the feet. The findings were most reminiscent of polyneuropathy of the legs.

Diminished reflexes were found in two patients in groups C and D taken together.

In summary: two patients showed unmistakable neurological dis-

orders, which in one resulted from a traumatic injury. The diminished arm and leg reflexes found in a total of 19 patients might be indicative of very slight or incipient polyneuropathy. However, these observations were fairly subjective and not repeated, and therefore warrant no definite clinical conclusions.

This field study revealed reduced function in all eyes with ophthalmoscopically evident POD and in nearly all eyes with suspected POD. All these patients therefore met the two criteria for a diagnosis of optic atrophy (chapter II). In the following chapters these patients will be referred to as suffering from optic atrophy or suspected of optic atrophy, without further definition of ophthalmoscopic findings.

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FAMILY STUDY

1. *Pedigree study*

Chapter IV defines the sources of the data for the pedigrees prepared during the field study. In many cases vast distances had to be travelled in order to trace a single family member. Oral information on family relationships was always verified on the basis of one of these sources, and rarely found to be incorrect. In this way I prepared the pedigrees A, B and C (shown in figures IX-1, IX-2 and IX-3).

A striking feature of these pedigrees is that only two consanguine-

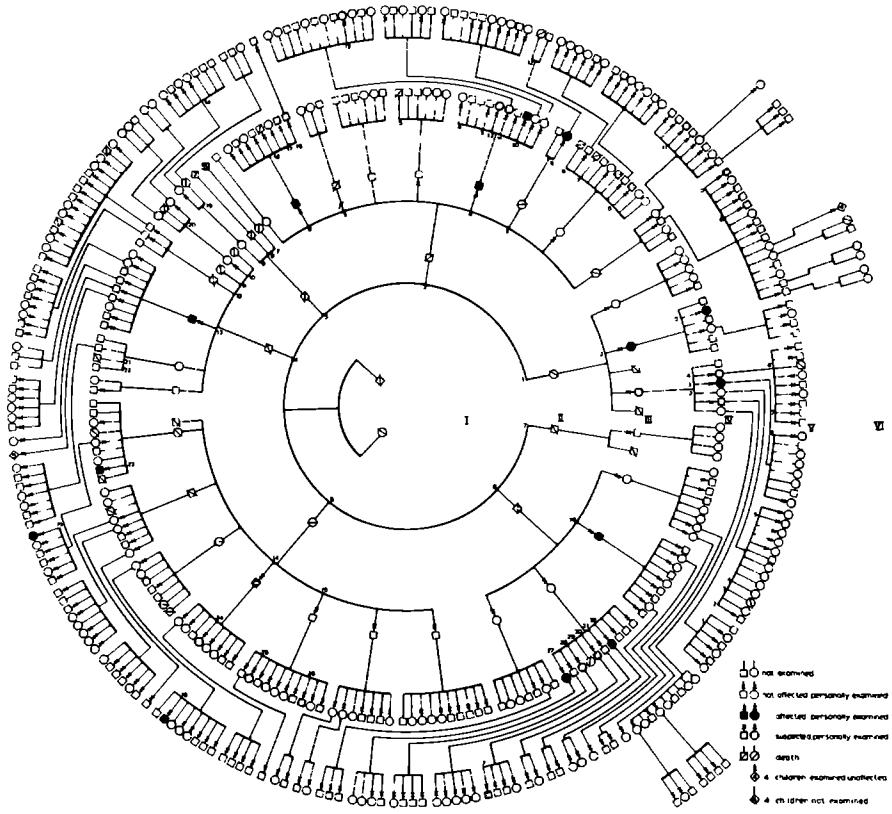

FIG. IX-1. Pedigree A

ous relationships were demonstrable. I found that there is a strong taboo on consanguineous relationships among the Creoles of the Para district. Individuals are well-informed about the structure of their family, and this facilitates adequate social control in this context.

The following may serve to illustrate the difficulties encountered in the pedigree study: when taking the history of one of the family members, I was informed that a family relationship existed between A II-4 and his wife. Figure IX-4 shows the relationship as it was found to be.

This figure shows that the relationship was not consanguineous, but in order to demonstrate this I had to trace back to 1813.

Pedigree C (fig. IX-3) represents a lateral branch of the A family in which no optic atrophy was found but glaucoma was present. An interesting fact in this respect is that the primogenitor of this branch

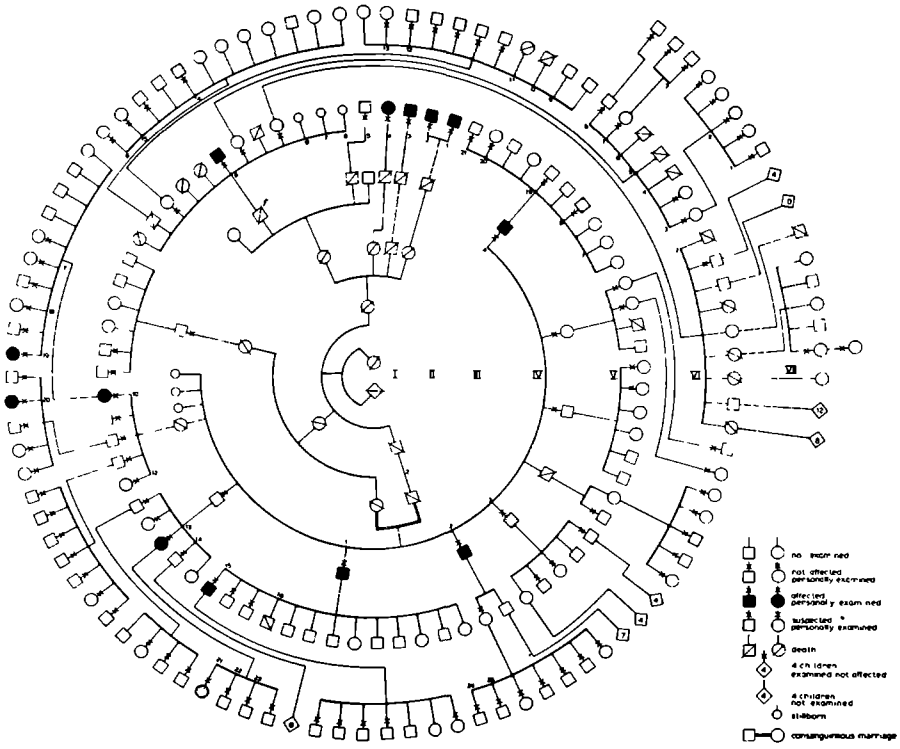

FIG. IX-2. Pedigree B

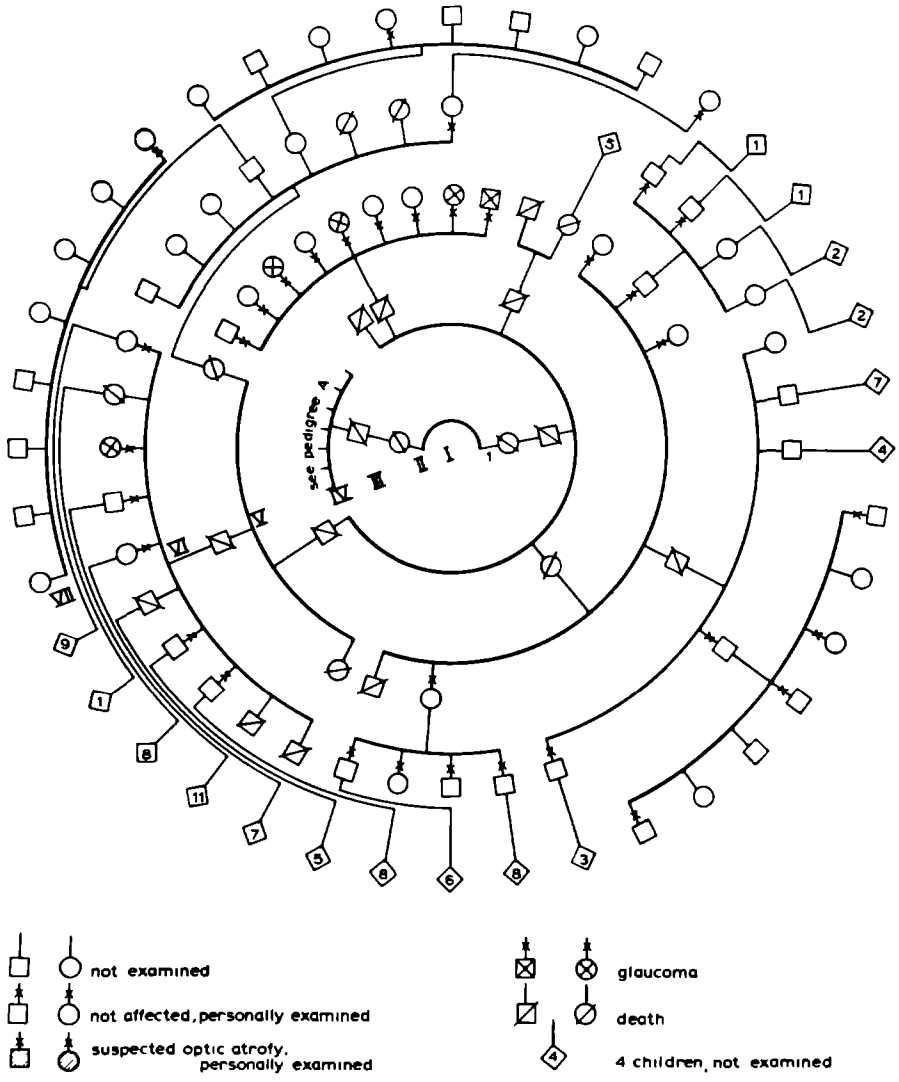

FIG. IX-3. Pedigree C

(husband to C II-1) was a European (about 1800).

In pedigree A (fig. IX-1) we find that optic atrophy is present (both in males and in females, and in consecutive generations) but is so sporadic that it warrants no conclusions concerning heredity.

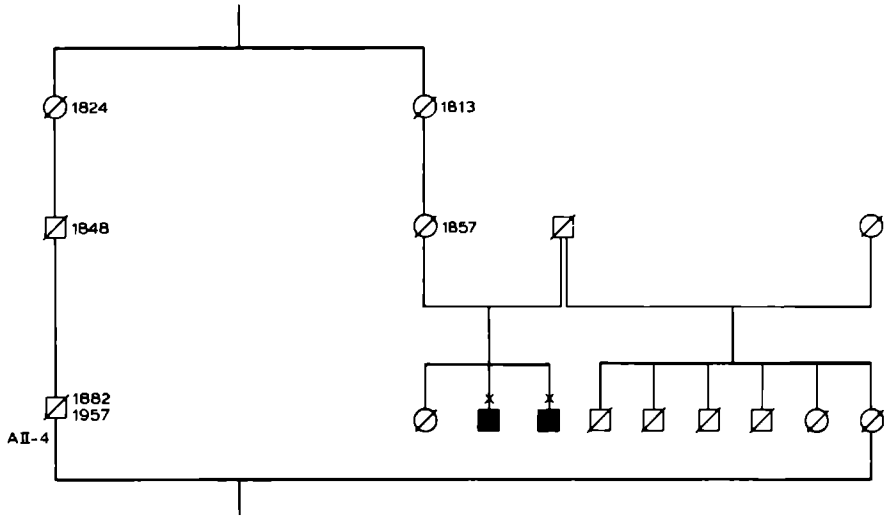

FIG. IX-4. Family relationship between A II-4 and his wife (for explanation of symbols, see figures IX-1, IX-2 and IX-3).

2. Analysis of pedigree B

Optic atrophy is less sporadic in that branch of pedigree B (fig. IX-2) that arises from the consanguineous marriage (B III-1 and -2). This branch will be analysed, and for some modes of transmission an effort will be made to establish the extent to which the relevant criteria are fulfilled. The patients not examined will not be considered, and the dubious cases will be accepted as verified optic atrophy cases.

In this branch we examined:

47 males, including 6 with OA (4 verified, 2 dubious)

29 females, including 6 with OA (4 verified, 2 dubious).

a. Autosomal dominant transmission

Father-to-son transmission occurred twice, father-to-daughter transmission once, and mother-to-daughter transmission once. Mother-to-son transmission did not occur. The affected male: affected female ratio is 6/47 : 6/29 = 3 : 5. Instead of the 50% that should be affected, 15.8% were. The affected persons had a total of 32 offspring examined, including 4 who were affected. This is only 12.5% instead of the 50% to be expected in autosomal dominant transmission.

The above data indicate that regular autosomal dominant transmission is to be excluded.

b. X-linked recessive or dominant transmission

As many males as females were affected. Father-to-son transmission occurred twice. This shows that X-linked transmission is to be excluded.

c. Autosomal recessive transmission

There were four instances of transmission in consecutive generations after a consanguineous marriage. This excludes simple recessive transmission. Alternative possibilities are:

1. Intermediate transmission:
In this case the heterozygotes should also show hereditary characteristics, and about 50% of persons should be affected (the percentage was in fact far smaller).
2. Pseudodominance:
This mode of transmission is based on a very high gene frequency in the population involved, or a high frequency of consanguineous relationships. In that case, 50% of the offspring should be affected. Only 12.5% were in fact affected, and this mode of transmission is consequently also excluded.

The above has disregarded the possibility of reduced penetrance or expression. It seems unrealistic to consider these possibilities, because there were no pertinent indications in that direction.

Simple mendelian hereditary transmission does not seem to be involved.

Addendum 4 lists the causes of death traced for pedigrees A and B, respectively (deaths of old age are not included). The principal causes of death proved to be accidents and infections. Anamnestic evidence of neurological disorders was found in three persons in pedigree A and one in pedigree B. Glaucoma was found twice in pedigree A and once in pedigree B (0.7% and 0.9%, respectively, of the persons examined).

NUTRITION

1. *Nutrition studies in the past*

A diet inventory study by Van der Kuyp (1963) among Javanese, Hindustani and Creoles showed that, of these three ethnic groups, the Creoles had the highest and the Hindustani the lowest intake of animal proteins, animal fats, vegetables and animal vitamins. The three groups were believed not to differ in thiamine and riboflavin intake. Alcohol consumption was highest among the Hindustani and lowest among the Javanese. The Javanese were the heaviest and the Creoles the least heavy smokers.

The Bush Negro diet proved to be deficient in animal proteins, fats and vitamins (Van der Kuyp 1962). Bush Negroes eat substantial amounts of cassava, a rootstock staple food which consists almost entirely of carbohydrates and contains only 0.5-0.75% protein (Van der Kuyp 1970).

The lowland Indians were found to have a qualitatively and quantitatively adequate diet with much fish and meat (Van der Kuyp 1966).

Between 1958 and 1969, Luyken carried out some nutrition studies in Suriname, including balance studies (Luyken 1960, 1961, 1963, 1966 and 1967; Zeegelaar 1967).

Javanese, Creoles, Hindustani and Indians as a rule proved to show no serious deficiencies. The protein content of the Bush Negro diet is low, but generally not below the generally accepted limit of 0.5 g/kg body weight (WHO 1974). However, the animal protein content is low (slightly over 25%). Balance studies showed, however, that the relatively low protein intake is nevertheless sufficient to meet physiological requirements. The serum cholinesterase activity in Bush Negroes was found to be low, and this may suggest a relatively low protein content of the diet. Classical signs of protein deficiency are rarely observed in young and adult Bush Negroes.

A risk of severe protein deficiency exists only at the transition from breast-milk to more solid foods (between the third and the fourth month of life). The cassava porridge then usually introduced contains virtually no proteins (Voedingsnieuws 1966).

The results of recent serum vitamin (particularly B complex) analyses are not yet available.

Bush Negroes in particular have a very high carbohydrate intake and therefore high thiamine and niacin requirements; consequently B complex avitaminosis may be present when the dietary content of these vitamins is marginal.

2. *Personal observations on nutrition*

Personal observations were made in an inquiry into the nutritional habits of the Creoles in the Para district (1977). The findings seemed to suggest the following adult male 'average menu' (per day):

3-4 cassava loaves (i.e. 360-480 g)
200-300 g meat or fish
two ample helpings of vegetables
alternately rice or boiled sweet cassava (400-500 g of the latter)
regular helpings of yam, pomtayer and banana.

Until recently, virtually all infants were fed kokori porridge (made of cassava-meal) from the 3rd to 4th month of life on. This is gradually changing, however, and the kokori porridge is being replaced by rice porridge and bread (but by no means every day).

The Hindustani showed some interindividual differences, but as a rule had a daily menu of fish or meat, with vegetables and regularly fruit. Hindustani eat little or no cassave but have a high alcohol intake (particularly the males). The earlies muslim immigrants from British India are a separate group because some eat no meat, fish or egg (but do have milk, cheese and some sort of yoghurt on the menu).

The Indians had a well-varied diet with vegetables, meat and/or fish and fruit, even though like the Bush Negroes and the Creoles of the district they used cassave and cassava products as staple food.

3. *Cassava*

The cassava (*Manihot esculenta Crantz; Manihot utilissima;* manioc; bread-root) originates from South America. Legend has it that it was already being cultivated by the inhabitants of Brazil, Guyana and Mexico before the New World was discovered (Van den Abeele 1951; Sundararaj 1976).

The cassava was imported in Africa by Portuguese mariners in 1600

or about 1600, and rapidly spread through central Africa. Today it is being cultivated in all tropic regions of the world. Its shrubby plants reach a height of 2-3 m when cultivated (usually as yearling plant).

The roots for which the plant is cultivated consist almost exclusively of starch and contain linamarin, a cyanogenetic glucoside. In Suriname, a bitter variety is distinguished from a sweet one. It is assumed that the latter contains no or virtually no cyanogenetic glucoside; it can therefore be prepared as it is.

Cassava is a food of very limited value, which owes its popularity to the fact that it is cheap and easy to cultivate. It is a strong, high-yield crop which can stand droughts, and the roots can be stored in the ground for a long time. Its nutritional value, as pointed out, is very low.

It contains 0.5-0.75% protein, 0.33% glucose, 1% saccharose and dextrin, and 35% starch. The remainder of the dry substance consists largely of cellulose (Grace 1977).

In a study in Ivory Coast, De Bruyn (1971) found that both the toxic and the allegedly less toxic cassava contained the cyanogenetic glucosides linamarin and lotaustralin (ratio about 20:1), although differently distributed through the root. The glucoside content of the roots of the same plant can vary widely. The cyanogenetic glucoside content is highest at the insertion on the stock. The skin of the root has a higher cyanogenetic glucoside content than the central part, but in the 'toxic' varieties this difference is smaller than in the 'non-toxic' varieties. The toxicity of the roots can increase very rapidly at the start of the rainy season, and when the soil becomes exhausted.

Boiling of the toxic roots proved to break down the enzyme (linamarase) but to leave 90% of the glucoside in situ in the roots. In the 'toxic varieties' the enzyme activity in the root-skin was about 20 times as high as that in the central part of the root. Addition of juice prepared from the leaves or root-skin proved substantially to accelerate the hydrolysis of the glucoside in the shredded skinned root. Hydrolysis of the glucoside in pulverized unskinned roots took place within an hour.

It is generally assumed in Suriname that the so-called sweet cassave needs no special treatment of detoxification. The bitter ('toxic') variety is skinned almost immediately after harvesting; the skinned root is then shredded and stored for some time in a basin. It is then passed through a rush-plaited press (matapi), and dried. The juice thus obtained is used to prepare a kind of vinegar, and the dry material is

pounded into meal with which cassava cakes or loaves can be baked.

In many African regions, the root crop is first allowed to rot, unskinned. The high linamarase concentration in the skin then ensures very complete hydrolysis of the glucoside.

4. HCN contents of cassava and cassava products

I made a preliminary study of the HCN contents of bitter and of sweet cassava and of cassava products ready for consumption, used both by district Creoles and by Indians.

Duplicate determinations were made in 52 samples, using a titration method. The determinations were made at the laboratory of the Paramaribo food inspection service, under supervision of (Miss) Dr. Ir. Kong Tse Lam (this is a department of the Public Health Service. Director: Prof. Dr. B. F. J. Oostburg).

The samples were macerated in a closed Kjeldahl bottle and submitted to steam distillation. The distillate was collected in 20 ml 0.0207 N $AgNO_3$ and acidified with 1 ml HNO_3. After this re-tritation of the surplus of $AgNO_3$ was done with 0.0201 N KCNS, using Fe aluminium as indicator.

Table X-1 lists the amounts of HCN obtained from the various samples from Creoles and Indians.

Cyanogenetic compounds were demonstrated in nearly all samples, from Creoles and from Indians, although the concentrations varied widely. The findings obtained by the crude titration method should be interpreted with caution.

The results of the duplicate determinations in many of the samples differ little, and this may be an indication of the reliability of the determinations made.

Part of the HCN released at distillation binds again immediately, and the values found for cyanogenetic compounds with this method must therefore be too low (De Bruyn 1971).

These were samples collected during one particular season (from halfway the long rainy period to the end), and in this respect, too, marked seasonal fluctuations are to be expected.

I was able to confirm the distribution of cyanogenetic compounds

TABLE X-1. Cyanogenetic glucoside concentration in mg HCN/100 g sample in Creoles and Indians (double figures are duplicate determinations; figures in italics are averages)

	bitter cassava		sweet cassava		freshly pressed cassava	cassava water, not detoxicated	cassava water, detoxicated	cassava loaf	kokori	kokori porridge	sweet cassava	
	skin	core	skin	core							boilt	baked
Creoles	102.6	20.5-20.4	46.7-37.2	9.4	12.1-11.1	27.8-28.6	10.9	3.8	1.7	2.8-2.3	0.6-0.5	2.6-2.2
	59.3-57.1	50.6-49.9	50.3	16.4-14.3	39.1-40.9	59.7-57.9	23.1-23.1	1.9-2.3	1.0		0.0	
	49.5-49.3	37.8-38.6	56.8	5.1- 4.8			14.5-14.3	0.6-1.0	1.6-1.7		1.6-1.7	
	18.1	6.0- 8.2	42.2-46.3	16.2-16.3			41.4-48.1	2.7-3.7	0.5-0.5			
	89.0-85.0	8.1-12.9						0.6-0.6	8.6-7.9			
								1.4-1.6	1.1-0.9			
								0.0				
								1.4-1.6				
								0.0				
	63.7	*25.3*	*46.6*	*11.8*	*25.8*	*43.5*	*25.1*	*1.5*	*2.5*	*2.5*	*0.9*	*2.4*
Indians	44.5-42.6				17.6-17.0	10.4-10.4	5.6	5.4-5.4	17.1-16.3		1.3-0.5	
	99.6-101.8	70.5-71.3					2.5- 2.4	0.6-0.6	0.5- 0.6			
								0.9-0.5				
	72.1	*70.9*			*17.3*	*10.4*	*3.5*	*2.2*	*8.6*		*0.9*	

in the root of the toxic and the less toxic cassava variety as reported by De Bruyn in 1971.

This study showed that, contrary to general opinion, *the various cassava products used by two population groups in Suriname (Creoles of the Para district and Indians of the Saramacca district) are not free from cyanogenetic compounds.* This question had not been previously investigated in Suriname.

5. Daily intake of food containing cyanide

Application of the values found to the 'average' diet of the adult male in the Para district reveals a daily intake of cyanogenetic compounds equivalent to 9.0-11.7 mg HCN (360-480 g cassava loaf equals 5.4-7.2 mg HCN; 400-500 g boilt sweet cassava equals 3.6-4.5 mg HCN).

The kokori porridge used to feed infants contains the equivalent of 2.5 mg HCN per 100 g.

6. Comparison with some cassava products in West Africa

In a study of the toxicity of cassava foods in 1966, Oke found the following HCN contents in samples of cassava and cassava products used in Nigeria:

fresh cassava	: 38.0 mg HCN/100 g sample
gari (comparable to kokori)	: 1.9 mg HCN/100 g sample
fufu (comparable to kokori porridge)	: 2.5 mg HCN/100 g sample

In 1965, Wood found a HCN content of 2.5 mg/100 g gari, which after a month's storage was decreased to 0.2 mg/100 g sample.

These values do not differ much from those I found in Suriname.

As regards the toxicity of HCN, Boluis (1954) estimated the lethal dose of HCN for an adult man weighing 50 kg to be 50-60 mg/day.

I lacked the time and the means for a more comprehensive nutritional study. It can nevertheless be maintained that the generally accepted principal parameters concerning the relation between nutrition and optic atrophy were taken into account, with the exception of the recently revealed role that zinc deficiency can play in optic neuropathies (Broderick 1974; Moynahan 1976; Leopold 1978).

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DISCUSSION

1. *Epidemiology*

Optic atrophy is quite common in Suriname (3% of the new outpatients of the AH, 3.6% of the MEU patients and 1.5% PP patients were new cases of OA). Although AO was usually accompanied by a significant decrease in visual acuity, it led to blindness in only a minority of cases (7% of the patients with OA had VODS $\leq$ 0.05). Blindness statistics of other countries therefore supply no material for comparison. Moreover, the various countries do not apply the same criteria of blindness (Schappert-Kimmijser 1959; Ten Doesschate 1968). With the exception of Jamaica, no other countries to my knowledge have directly comparable data on the incidence of OA.

In Jamaica, where OA is relatively common, 2-2.5% of all ophthalmological patients at the Kingston hospital showed bilateral OA in 1956 (Degazon 1956). During the period 1950-1975, this percentage averaged 2.3 in Suriname. In The Netherlands, about 450 new blind and visually handicapped patients (visual acuity $\leq$ 0.3) reported to the AIB Foundation (Foundation for the General Individual Interests of the Blind) in 1976. Of the 260 persons on whom ophthalmological data were available, 45 were suffering from bilateral OA (Ten Doesschate, personal communication) in a total population of 13,750,000.

During the period 1950-1975, the annual number of new patients registered as suffering from bilateral OA with a visual acuity of $\leq$ 0.3 averaged 44 in Suriname. During this period Suriname averaged a total population of 300,000 (table V-4A).

Of the patients with OA on record at the AH, 58% of the Creoles, 66% of the Bush Negroes and 36% of the Hindustani had bilateral unexplained OA.

Bilateral unexplained OA was much more common in Creoles and Bush Negroes than in Hindustani. The difference between Creoles and Bush Negroes on the one hand and Hindustani on the other, changed in the course of the period 1950-1976, as shown by the records on bilateral unexplained OA of the AH in Paramaribo city. In the earlier years of this period, this type of OA was 14 times as frequent in Creoles and twice as frequent in Bush Negroes as in Hindu-

stani over age 15. At the end of the period, the incidence in Creoles was 3.5 times and that in Bush Negroes was 7.6 times the incidence in Hindustani. In the remaining population groups, the incidence of OA was low.

The Hospital Incidence Rate (HIR) in Creoles is markedly decreasing while that in Bush Negroes is increasing and that in Hindustani has remained virtually unchanged since 1963 (see table V-5). These differences in the incidence of bilateral unexplained OA might be explained by:

a. An unidentified diagnostic shortcoming which plays a more important role in Creoles and Bush Negroes than in Hindustani.
b. A hereditary factor.
c. A hereditary combined with an exogenous factor.
d. An exogenous factor.

re a: In this case it can be expected that, with improved diagnostic methods, the decrease in the HIR of unexplained OA in the course of the years should be the same for the various ethnic groups. This, however, has not been the case (we can proceed from the postulate that diagnostic methods have been the same for the various population groups). It cannot be excluded, however, that the increased HIR in Bush Negroes is caused by the increased medical accessibility of this population group, which lives in the interior.

re b: If only hereditary factors would play a role, then the rapid decrease in the HIR of unexplained OA in the Creoles could only be explained by:

1. Infertility of the patients or the carriers of the gene.
2. Strictly given and strictly followed genetic advice.
3. Abolition of the isolation in the case of autosomal recessive transmission. In that case a very high gene rate can be expected in the population involved (even yet, because this isolation would have been abolished in the course of the past 25 years); but chapter IX has shown that this is not the case.

These three possibilities can all be ruled out. Remain only the possibilities c and d, according to which the changed HIR in the course of the years should be explained on the basis of an inconstant exogenous factor.

There was no difference in incidence between males and females.

2. *Clinical features*

Not only was the HIR (and therefore the frequency of occurrence) of bilateral unexplained OA higher in Creoles and Bush Negroes than in Hindustani, but it also accounted for a larger percentage of the various groups of OA (groups I, II, III and IV) in Creoles and Bush Negroes than in Hindustani. The records of the AH show that bilateral unexplained OA occurred in 59.5% of all Creoles, 67.7% of all Bush Negroes and 33.4% of all Hindustani with OA (see table VII-1).

Explained OA was percentually more common in Hindustani (32.6%, versus 13.4% in Creoles and 13.3% in Bush Negroes).

These figures also indicate that, in Creoles and Bush Negroes, an unidentified factor must play a role which causes OA, and particularly bilateral OA, to be much more often interpreted as unexplained than in Hindustani.

This discussion will be confined to bilateral unexplained and bilateral suspected OA.

a. The features of the optic disc

The optic disc in bilateral unexplained OA was mainly characterized by temporal pallor (tables VII-3 and VIII-1).

b. The features of the retina

The retrospective study of case records revealed that, in both groups of OA, about 90% of cases showed no retinal lesions (table VII-4). In the field study the percentage without retinal lesions was smaller (table VIII-2). Slight pigment changes in the macular region and constricted arteries were found much more often in this field study. The extent to which these changes were related to the OA remained obscure.

c. Visual acuity

Visual acuity was found to vary widely within the same group of OA. The retrospective study (table VII-7) revealed visual acuity < 0.5 in 51.4% of Creoles (< 0.1 in 23.0%) and 70% of Bush Negroes (< 0.1 in 40.3%). In the field study (table VIII-3), 53.1% of the group A patients (the 'random' patients with bilateral unexplained OA) had visual

acuity < 0.5 (< 0.1 in 34.4%), the corresponding figures in group B (patients of the pedigree study) being 39.5% and 23.7%. In the retrospective study of patients with suspected OA, 26.8% of Creoles had visual acuity < 0.5 (< 0.1 in 8.3%), the corresponding figures in Bush Negroes being 51.0% and 25.0%. Of the patients with suspected OA in the retrospective study, a large proportion therefore proved to show a significant decrease in visual acuity. This finding was not confirmed in the field study, which revealed no difference in visual acuity between this group of OA and the group without optic neuropathy.

d. Visual fields

Visual field defects were demonstrable in virtually all patients with bilateral unexplained OA examined, and in 75% of the patients with suspected OA (table VIII-4). However, an entirely specific visual field defect was not found. The most common finding was a combination of decreased general sensitivity with paracentral or central absolute and/or relative scotomas, more or less marked peripheral limitation and an enlarged blind spot (fig. VIII-2).

Minor visual field defects (but never scotomas) were also found in 28.6% of the persons without optic neuropathy.

e. Pupillary reactions

Conspicuous (asymmetrical) pupillary reactions were not observed. In some cases, however, there was unmistakably slow constriction with symmetrical pupillary escape (table VIII-5). These findings may suggest disturbed afferent conduction of the optic nerve. The asymmetrical pupillary reactions (swinging flashlight phenomenon, or Marcus-Gunn pupillary reaction) so important in the diagnosis of an afferent conduction disorder, could not be demonstrated because the patients examined always showed bilateral optic neuropathy.

f. Intraocular pressure

No indications were found that patients with the various types of OA had a higher than normal intraocular pressure (table VIII-6). However, this finding does not exclude the possibility of an increased sensitivity of the optic disc to a given intraocular pressure. The fact remains that none of the patients showed glaucomatous disc cupping.

g Colour vision

The group without optic neuropathy and that with suspected OA showed virtually no colour vision defects (table VIII-7). Of the patients in group A ('random' patients with bilateral unexplained OA), 40.9% showed colour vision defects. Of the eyes examined by the OA H-R-R test, 27.3% showed a combination of a red-green with a blue-yellow defect, and 13.6% showed a pure red-green defect. In group B (pedigree study patients), 13.6% of patients showed a pure red-green defect. The combination of a red-green with a blue-yellow defect was not found in this group. Moreover, one of the patients in this group showed a pure blue-yellow defect.

h. Age

The retrospective study revealed that bilateral unexplained OA increased in frequency with increasing age. At about age 40, there was a marked increase in the number of patients in whom this diagnosis was first made. This finding was confirmed in the field study (table VIII-9) in more than 50% of patients able to trace this, the eye symptoms had first developed between age 30 and age 50.

i Venereal serology

Group A ('random' patients) did not include a single patient with positive venereal serology (as confirmed by means of the FTA-abs. test) (table VIII-10). Group B (pedigree study patients) included one case (5.3%) with a positive FTA-abs test in association with bilateral unexplained OA. This patient was known to have suffered from yaws in the past, and this may have explained the positive venereal serology. Neither the retrospective study nor the field study ever revealed Argyll Robertson pupils.

j. Anamnestic findings

Gradual diminution of visual acuity was reported in all cases In groups A, B and C (patients with suspected OA) together, a correlation between a disease and decreased visual acuity was indicated in only one instance (decreased visual acuity two years after a bout of malaria).

Group B included one patient who had been an excessive drinker and smoker until two years before examination; this patient indicated that eye symptoms had started over 20 years ago. Only one patient suffered from insulin-independent maturity-onset diabetes mellitus.

k. Neurological examination

Severe neurological disorders were not found (table VIII-11), but I interpreted arm and leg reflexes as too low in 43% of group A and 42% of group B patients. These two groups also showed the highest incidence of minor sensorineural hearing loss (25% in group A and 21% in group B), but this was found almost exclusively in elderly patients (> 60), and therefore mostly likely involved presbycusis.

Two patients in group A (12.5%) and two in group B (10.5%) indicated paraesthesias (tingling sensations in the hands and/or feet). Group B included one patient with a polyneuropathy of the legs.

The minor neurological changes found might be suggestive of very slight or incipient polyneuropathy, but these observations were all highly subjective. No distinct symptoms of vitamin B deficiency (beriberi, pellagra, rhagades) were found in the patients examined. The records of the AH were likewise seldom found to contain any notes on this deficiency.

l. Pedigree study

Of the three families in the Para district for which pedigrees were prepared, two regularly included bilateral unexplained OA; there are therefore indications of a familial occurrence of this pathology in these families. However, simple mendelian hereditary transmission was not demonstrable. X-chromosomal transmission was excluded (chapter IX).

3. Aetiology

On the basis of the classification discussed in chapter III, the aetiology of OA in the Creoles of Suriname may now be considered.

I. Demyelation

1. Due to unknown cause

In none of the records of the AH studied was a diagnosis of multiple sclerosis mentioned. Moreover, the various neurologists active in Suriname in the past few decades have made this diagnosis only very sporadically (Jessurun 1977, personal communication; Baal 1979, personal communication). The literature (Cruickshank 1956; Vinken & Bruyn 1972) likewise mentions that multiple sclerosis occurs only sporadically in the negroid race and in a tropical climate as compared with more temperate regions. Of the diseases mentioned sub Ia in chapter III, the neurological symptoms were absent, or the further clinical course excluded them as possibilities (Katz 1961; Zeman 1962; Croft 1965[a,b]; Walsh & Hoyt 1969; Glaser 1978).

2. Due to infections

a. Viral infections. Several viral infections, including measles, take a more severe course and entail a higher risk of complications in the tropics than in temperate regions (Morley 1963, 1969; Okojie 1969; Wilcocks 1972). These infectious diseases, too, can be associated with an optic neuropathy and possibly with OA, but in that case there are usually serious neurological complications (Appelbaum 1962; Miller 1964; Quéré 1964; Henle 1965; Ford 1966; Naumann 1968; Walsh & Hoyt 1969; Silverstein 1974). There were neither anamnestic nor clinical indications that any of the patients examined in Suriname had had any of these diseases with serious complications.

b. Bacterial infections. Bacterial infections rarely produce complications in the form of an optic neuropathy (Corcelle 1963; Vladykova 1964; Scott 1971). Unlike viruses, moreover, bacterial toxins have never been demonstrated to have a neurotropic effect. In none of the cases studied were there anamnestic or neurological indications of any of the bacterial infections with complications listed sub Ib in chapter III.

c. Rickettsiae. Optic neuropathies develop relatively often in cases of epidemic typhus (Morax 1961; Lebas 1963). None of the patients examined indicated ever to have had any disease resembling epidemic typhus (in the past 25 years, moreover, there have been no typhus fevers epidemics in Suriname).

d. Protozoa. Optic neuropathies have been reported in malaria and trypanosomiasis; very likely, however, these resulted from the medication (Debeir 1954; Ford 1966; McKie Reid 1972) and were accompanied by an acute decrease in visual acuity. An acute decrease in visual acuity was mentioned in only a few of the case records studied, and was not indicated by any of the patients examined. An optic neuropathy can also occur in acquired toxoplasmosis, but is always associated with severe neurological disorders such as encephalitis (Krepler 1965).

e. Filariasis. Some authors have reported optic atrophy in a large percentage of patients with ocular onchocerciasis (Bird 1976); areas of chorioretinal atrophy were found in most of these cases. None of the patients with bilateral unexplained optic atrophy examined in Suriname showed chorioretinal lesions. Moreover, neither ophthalmologists nor dermatologists diagnosed onchocerciasis in Suriname during the period 1950-1976.

II. Vascular aetiology

1. Diminished perfusion pressure

Hypotension (due to various causes) can cause atrophy of an optic nerve that is predisposed to it (due to less than optimal vascularization) (Smith 1961; Hollenhorst 1962; Foulds 1969; Carroll 1973; Drance 1973). In these cases, however, there is nearly always an acute decrease in visual acuity with ischaemic choked disc and haemorrhages. Of the patients I examined, one indicated a postpartum haemorrhage. Visual acuity, however, did not diminish until a few years later and the decrease took a gradual course; an aetiological relation to the haemorrhage is therefore improbable.

2. Increased resistance in the optic disc

Arteriosclerosis is an important cause of ischaemia of the optic disc (François 1957; Calmettes 1963; Bonamour 1968; Foulds 1968; Hayreh 1975). Normal retinal vessels do not exclude arteriosclerotic changes of the posterior ciliary arteries (Uhthoff 1923; Igersheimer 1929; Hayreh 1975).

The decrease in visual acuity is generally acute or subacute, but gradual, progressive decreases have also been described (Knox 1971).

Although an aetiology based on arteriosclerotic changes could not be excluded in the older patients examined, it is unlikely that arteriosclerosis could play a major role in the optic neuropathies studied in Suriname, for 50% of the patients examined began to complain about visual acuity between age 30 and age 50 (chapter VIII), and arteriosclerotic optic neuropathies develop mostly between age 60 and age 65 (Glaser 1978). The various types of arteritis can also be excluded in view of the clinical course (Hayreh 1975).

There was no increased intraocular pressure in the patients examined (chapter VIII). This, however, does not exclude the possibility of increased sensitivity of the optic disc to a given intraocular pressure. Yet none of the visual fields examined showed any evidence of fibre bundle defects (chapter VIII). Centrocaecal scotomas can occur in association with glaucoma, but this is exceedingly rare (Carroll 1968).

None of the patients showed retinal changes of the kind to be expected when the blood viscosity is significantly increased: dilatation and tortuosity of the veins and sometimes of the arteries, pathological arteriovenous crossings, occlusion of veins, retinal haemorrhages and sometimes capillary microaneurysms, exudates and so-called cotton-wool spots (Carr 1963; Luxenberg 1970; Chester 1973). In an advanced stage, the features may closely resemble those of central retinal vein occlusion (Mausolf 1975). Several causes of a hyperviscosity syndrome were excluded during neurological examination and on the basis of anamnestic findings. Specifically, none of the patients complained of ostealgia and there were no pathological fractures or haemorrhages, and no swollen lymph nodes. Nor did any patient mention frequent headaches, dizziness, deafness or fluctuating changes in visual acuity (often found in assosiation with a hyperviscosity syndrome).

3. Disturbed blood oxygenation

Severe pulmonary affections were excluded on the basis of the anamnestic findings and clinical observations. Due to an error of organization, no Hb determinations were made in the patients examined. In none of these patients, however, was the appearance of the conjunctival mucosa suggestive of severe anaemia. In the few case records (retrospective study) which did mention the Hb concentration, this never was markedly decreased. Chronic moderately severe anaemia, however, cannot be excluded on the basis of the available data. Chronic moderately severe anaemia, however, is a rare cause of optic atrophy (Walsh 1978).

If this factor plays a role the first symptoms of optic neuropathy are likely to develop during or immediately after a pregnancy, when the Hb has decreased even further. None of the female patients examined indicated this (one patient did suggest a relation to parturition, but eye symptoms had first occurred four years after the last parturition). One patient had a history of severe malaria, but this had been 10 years prior to the gradual decrease in visual acuity.

The above suggests that anaemia is not likely to have played an important role in the aetiology of this type of OA. However, haematological research will certainly have to be done.

III. Tumours

In the retrospective study, all cases of optic neuropathy which were later found to involve a tumour were interpreted as explained (chapter VII). Nearly all these cases involved unilateral OA.

Arguments against an aetiology based on intraorbital or intracranial tumours in the patients examined in the field study are:

the visual field findings (chapter VIII),
the simultaneous, symmetrical pathology,
the absence of other neurological symptoms.

IV. Intoxications

This subsection systematically discusses the possibilities of intoxation mentioned in chapter III under heading IV. In this discussion, the following references frequently play a role:

Leibold, J.E.: Drugs having a toxic effect on the optic nerve. Int. Ophthalmol. Clin. 11:137, 1971.

Hermans, G.: Les effets nocifs des médications générales sur l'appareil visuel. Bulletin de la Société Belge d'Ophtalmologie 160: 1, 1972.

Grant, W.M.: Toxicology of the Eye, 2nd ed. Thomas, Springfield Ill., 1974.

Lyle, W.M.: Drugs and disease conditions which may affect color vision. J. of the Amer. Optometr. Ass. 45 (1): 47-60 and 45 (2): 173-182, 1974.

Fraunfelder, F.T.: Drug-induced ocular side effects and drug interactions. Lea & Febiger, Philadelphia, 1976.

1. Antimony

Compounds containing antimony are used in the treatment of schistosomiasis (bilharzia) and filariasis. Ocular side effects (e.g. optic atrophy) have been sporadically described (Willets 1969; Goodman 1970; Blacow 1972; Roy 1972; Grant 1974; Lyle 1974; Fraunfelder 1976). In Suriname, schistosomiasis occurs mainly in the districts Saramacca and Nickerie, but not in the district in which the field study was carried out (Para). Filariasis occurs mainly in Paramaribo city. None of the patients examined reported ever to have been treated for either of these two diseases.

2. Arsenic

Some heavy metals (including organic arsenic compounds) can cause OA (Sloan 1961; Cogan 1966; Willets 1969; Duke Elder 1971; Ellis 1971; Hermans 1972; Roy 1972; Grant 1974; Lyle 1974). Arsenic compounds are obsolete; in the past they were used for the treatment of syphilis, but since World War II these compounds have not been used in Suriname. Organic arsenic compounds, which are present in very low concentrations in tonics also available on the Suriname market, have rarely caused ocular complications (Hermans 1972) and never optic neuropathies.

3. Aspidium

Aspidium (Dryopteris filix-mas) is an anthelmintic only rarely still used in the treatment of taeniasis. The agent can cause transient lesions of the optic nerve (permanent damage if used in large doses) (Cogan 1966; Duke Elder 1971; Hermans 1972; Grant 1974; Lyle 1974). Until recently, district medical officers occasionally still prescribed this agent in Suriname, but always in single doses. Symptoms of intoxication which may develop in response to an overdose are always acute (Hermans 1972). None of the patients examined had shown an acute decrease in visual acuity.

4. Barbiturates

Barbiturates are used as sedatives, hypnotics, anaesthetics and anticonvulsants. Numerous ocular side effects have been described (Hermans 1972; Grant 1974; Lyle 1974; Fraunfelder 1976). Disorders of ocular motility are involved in the majority of cases. Very severe pathological changes can occur in response to overdoses (barbiturate coma) and long-term medication with large doses. Optic atrophy has

been described in a few, older, publications (mentioned by Fraunfelder 1976). None of the patients examined in the field study was a barbiturate user.

5. Carbon disulphide

This is a highly volatile gas, which may be inhaled by workers in the rubber and rayon industries. Chronic inhalation can give rise to various lesions of the central and the peripheral nervous system. Retrobulbar neuritis in particular has been frequently described (Uhthoff 1931; Teleky 1975). More recent authors maintain that the primary pathology is vascular (Brieger 1967; Cesáro 1967; Gavrilescu 1967; Maugeri 1967; Savić 1967; Szymankowa 1968). In none of the patients examined can carbon disulphide have played a role.

6. Carbon monoxide

Inhalation of this gas can cause severe neurological disorders due to inadequate oxygen supply to the CNS, because part of the haemoglobin is converted to a form which cannot bind oxygen (carboxyhaemoglobin). Permanent damage develops only if the patient has lost consciousness for some time (Grant 1974). There are generally no specific fundus changes after CO intoxication (Grant 1974), but a few cases of optic neuropathy have been described in the past (neuritis, optic atrophy) (Wilmer 1921; Levy-Valensi 1924). A few more recent publications have described decreased visual acuity of cortical origin (Garland 1967; Benson 1969). None of the patients examined was known ever to have been poisoned by CO.

7. Carbon tetrachloride

This is a volatile solvent often used as detergent and cleansing agent. There are some reports on optic neuropathy (e.g. optic atrophy) after carbon tetrachloride intoxication (Smith 1950; Franceschetti 1952; Teleky 1955; Lyle 1961), but the correlation has never been demonstrated experimentally (Grant 1974). Some very obsolete anthelmintics against ankylostomiasis and oxyuriasis contains carbon tetrachloride. This agent, however, is highly toxic and has caused severe hepatic, renal and cardiac side effects (Asshauer 1969). So far as we know, however, this agent has never been used (at least not on a large scale) in Suriname. Nor was there anamnestic evidence of other regular contacts with compounds containing carbon tetrachloride.

8. Chloramphenicol

This is a widely used antibiotic which, particularly in long-term medication, produces many side effects (Hermans 1972; Grant 1974; Fraunfelder 1976). Particularly in children given large doses in long-term medication, optic neuropathies (e.g. OA) have been frequently described (Wallenstein 1952; Lasky 1953; Keith 1964; Cocke 1966, 1967; Chang 1966; Huang 1966; Lamba 1968; Kittel 1969). Optic atrophy develops after an average of 4-8 months of medication with large doses of chloramphenicol. In most cases it was described in mucoviscoidosis (Hermans 1972). Most patients showed fairly acutely diminished visual acuity (bilateral) with central or paracentral scotomas. Peripheral visual field defects can also occur (Hermans 1972). In many cases, visual acuity improves after discontinuation of chloramphenicol, but the optic disc remains pale. Chloramphenicol is still regularly prescribed in Suriname, especially for children with diarrhoea (but usually in small doses and rarely for more than 10 days). Optic atrophy has only sporadically been diagnosed in children in Suriname. All patients examined showed gradually diminished visual acuity, and none reported ever to have had long-term antibiotic medication (with the exception of one patient treated with penicillin for syphilis).

9. Clioquinol (Enterovioform®)

Optic atrophy as a result of clioquinol medication has been regularly described since the Sixties (Berggren 1966, 1968; Etheridge 1966; Editorial Lancet 1968; Van Balen 1971; Danis 1971; Editorial B.M.J. 1971; Nakae 1971; Bron 1972; Behrens 1974; Pinckers 1975). The optic neuropathy developed only after long-term use (several weeks) and took a subacute course. Some authors contend that these cases involved complications of viral infections (Inoue 1971; Shimada 1971). Clioquinol products are available in Suriname. It cannot be excluded with certainty that the patients examined had ever used these agents for a shorter or longer time. In all cases, however, the decrease in visual acuity observed was very gradual.

10. Cyanide

Several authors have related optic neuropathies to cyanide (Crews 1963; Smith 1965; Chisholm 1967; Darby 1967; Sandberg 1967; Wilson 1967; Foulds 1968[a], 1968[b]; Ohara 1968; Osuntokun 1968, 1968[a], 1968[b]; Foulds 1969; Osuntokun 1969; Foulds 1970[a]; Chisholm 1972; Foulds

1972; Lessell 1971[a], 1972; Pettigrew 1972; Foulds 1974; Grant 1974; Lyle 1974; Pinckers 1975; Bronte-Stewart 1976).

There has only been little experimental research into the specific sensitivity of the optic nerve to cyanide. Lessell (1971) found focal, bilateral retrobulbar necrosis of the optic nerve in 20% of rats treated with sublethal doses of NaCN. However, the corpus callosum proved to be more sensitive and more readily affected than the optic nerve (70% of rats treated). Lessell, and other authors mentioned in his article, regarded it as proven that cyanide can dammage the optic nerve. However, very large (up to sublethal) doses are required to produce this in rats. *Nothing is known about the possible consequences of slight chronic cyanide intoxication.*

Cyanide is assumed not to have a cumulative effect (Ferraro 1933; Lessell 1971), but this has not been established with certainty. Foulds (1972) and others injected double-labelled cyanocobalamin ($C^{14}NCo^{57}$) into rats and observed unmistakable accumulation of the radioactive carbon in the retrobulbar segment of the optic nerve. No carbon or Cobalt activity was observed either in the eye or in the brain. It has so far remained unproven that the accumulating cyanide carbon was still bound to the cyanide radical. Yet these results indicate that, in rats, cyanide seems to have a special affinity for the retrobulbar segment of the optic nerve.

Cyanide inhibits the activity of cytochrome oxidase, an enzyme required for tissue oxygenation (Van Houten 1961; White 1964). The white matter has a low cytochrome oxidase concentration (Lessell 1971), and this can explain the selective sensitivity of tracts consisting of white matter. Should there be exclusively a biochemical disorder (cytochrome oxidase inhibition), general involvement of the white matter could be expected (Levine 1967). Cyanide encephalopathy is potentiated by ligation of the carotid artery (Levine 1967), and shows a favourable response to oxygen administration (Way 1966). In this way, biochemical defects might be potentiated by vascular factors (Lessell 1971).

Detoxification of cyanide

In the organism, cyanide is mainly detoxicated to thiocyanate (Fiedler 1956; Brontë-Stewart 1976) in the intestinal mucosa, liver, kidneys and possibly also in other tissues (Clemedson 1960). The sulphur required for conversion to thiocyanate is obtained from the sulphurated animo acids cystine, cysteine and methionine. Vitamin B_{12} plays a role

as coenzyme in the methylation of homocysteine to methionine. This means that both protein deficiency (particularly of proteins with sulphurated animo acids) and vitamin B_{12} deficiency (and possibly vitamin B_6 deficiency) lead to a deficiency in sulphur available for detoxification of cyanide to thiocyanate (Pettigrew 1972; Brontë-Stewart 1976).

Moreover, cyanide can bind directly with hydroxycobalamin to produce the cyanocobalamin that can be excreted in the urine. Another possibility of detoxification, independent of the above reactions, is the reaction of cyanide with cystine, in which cysteine and B-thiocyanoalanine are released (Voigtlin 1926). The latter compound tautomerizes to 2-aminothiazolidine-4-carboxylic acid or to the equivalent 2-imino4-thiazolidine-carboxylic acid (Schoberl 1951; Wood 1956; Brontë-Stewart 1976). There are reasons to believe that the last-mentioned compound interferes with myelination and myelin turnover via its effect on choline synthesis, and can therefore cause demyelination (Lombardini 1970; Gandy 1973; Foulds 1974).

It can be concluded that a correlation between chronic cyanide intoxication and optic atrophy has been demonstrated to be plausible, but remains to be established with certainty.

As pointed out in chapter X, the population studied in Suriname is subject to the influence of cyanogenetic nutritional ingredients taken daily from earliest childhood on.

11. Dinitrobenzene

Dinitrobenzene used to be combined with chlorodintrobenzene to make explosives. Dinitrobenzene, chlorodinitrobenzene and dinitrotoluene have the same ocular side effects (Grant 1974). All cases described involved chronic industrial intoxications which gradually caused symptoms and, in a few sporadic cases, led to optic atrophy. The symptoms show some similarity to those of so-called tobacco-alcohol optic neuropathy. None of the patients examined in Suriname had ever worked in an environment which exposed him to the action of any of these chemicals.

12. Disulfiram (Antabuse®)

Disulfiram is used in the treatment of chronic alcoholism. Upon alcohol consumption it causes vasodilatation in the cervical and facial region, increased heart rate and respiration, followed by nausea, vomiting and decrease in blood pressure. These toxic effects are prob-

ably caused by the high aldehyde concentration which results from combined use of disulfiram and alcohol. Disulfiram itself is broke down to carbon disulphide, among other products (Fisher 1967). Side effects reported are usually bilateral reversible retrobulbar neuropathy (Humblet 1953; Perdriel 1966; Saraux 1970), but permanent pallor of the optic disc has also been described (Woillez 1962).

13. Ethambutol (Myambutol®)

Many instances of optic neuropathy have been described in association with ethambutol medication (Bobrowitz 1965; Berti 1967; Donomae 1968; Mine 1968; Asayama 1969; Citron 1969; Pahlitzsch 1969; Sole 1969; Yonekura 1969; Barron 1974; Deodati 1974; Pinckers 1975). In nearly all these cases the daily dose exceeded 25 mg(kg)/day, whereas complications were virtually absent at daily doses up to 15 mg(kg)/day (Grant 1974). Optic atrophy with irreversible diminution of visual acuity can develop when the medication is not discontinued in time (Keeping 1955; Yonekura 1969; Leibold 1971). The optic neuropathy generally recedes after discontinuation of the medication, but this may take 2-4 months (Leibold 1971).

There are indications that the lesion develops at the site of the optic chiasm (Leibold 1971; Lessell 1973). Several authors assume that the toxic effect of ethambutol is based on diminution of the serum zinc concentration (Buyske 1966; Saraux 1975; Editorial Am. J. of Ophthalmol. 1978). None of the patients examined in the field study had ever been treated for tuberculosis.

14. Ethanol (ethyl alcohol)

There is no convincing evidence that chronic or acute ethanol intoxication can cause OA. It seems likely that the blindness with OA due to alcohol abuse reported in the literature, was in actual fact caused by methanol (methyl alcohol) (Grant 1974). Alcohol consumption is likewise an inconstant factor in so-called tobacco/alcohol optic neuropathies. The literature reveals controversial views on the relation between alcohol and tobacco amblyopia (Dunphy 1969). The generally accepted view today is that so-called toxic ethanol optic neuropathies are actually vitamin deficiencies (Walsh & Hoyt 1969; Glaser 1978). Numerous ocular side effects have been described in association with ethanol consumption. This may be explained by the fact that the human alcohol consumption is surpassed only by his consumption of water.

15. Ethylhydrocupreine hydrochloride (Optochin®)

Ethylhydrocupreine hydrochloride is a chemical modification of quinine. It is an obsolete remedy, used in the past in the treatment of pneumonia and in the local treatment of ocular pneumococcal infections (Merck Index of Chemicals and Drugs 1968; Von Jess 1969; Grant 1974). Its toxic effects on the eye closely resemble those of quinine: acute diminution of visual acuity (after a few hours), often accompanied by hearing disorders. Retinal oedema and constriction of retinal arteries are observed in many cases. Visual acuity as a rule returns to normal within a few hours to days when the medication is discontinued, but some patients develop OA (Grant 1974). So far as I know, this remedy has certainly not been used in Suriname in the past few decades; moreover, none of the patients examined had had an acute diminution of visual acuity.

16. Iodoform

Iodoform was formerly used as local antiseptic and anaesthetic. General symptoms of intoxication with decreased visual acuity resulted from absorption after excessive application to wounds and abscesses. The (acute) diminution of visual acuity was usually caused by retrobulbar neuritis with a central scotoma. The return to normal was as a rule slow (a few months), and pallor of the temporal part of the optic disc often remained (Grant 1974). Not a single case seems to have been described in the past 40 years. Inorganic iodine compounds are considered not to be toxic to the eyes (Uhthoff 1931; Grant 1974). None of the patients examined in Suriname had had an acute diminution of visual acuity.

17. Isoniazid (isonicotinic acid hydrazide)

This agent is used in the treatment of tuberculosis. Optic neuropathy due to isoniazid is rare (Keeping 1955; Hermans 1972), and its evaluation is difficult because it is encountered as a rule in undernourished chronic alcoholics and in patients on multiple-drug medications (Fraunfelder 1976). Some authors have described OA which, in their opinion, resulted from isoniazid medication (Keeping 1955; Sutton 1955; Dixon 1956; Kass 1957). Honegger (1969) found reversible accommodation weakness in about 35% of patients treated with a combination of INH, streptomycin and PAS; it seemed to be related to the INH dosage. None of the patients examined in Suriname had ever been treated for tuberculosis.

18. Lead

Lead is found in paints and in petrol. Lead poisoning can cause many abnormalities of the optic system. Most cases of lead poisoning were reported in the early years of this century. The extensive pertinent literature was reviewed and summarized by Grant (1974) in his Toxicology of the Eye. Ocular complications probably develop in only 1-2% of cases of lead poisoning. Ocular symptoms are generally not among the first manifestations (apart from a few exceptional cases in children). Whether lead directly affect the optic nerve has remained obscure. In most cases it is impossible to establish whether the OA results from the encephalopathy with cerebral oedema and vascular changes, or from a retrobulbar affection which affects the optic nerve proper. Many patients show oculomotor disorders. In none of the patients examined in Suriname were any indications found of a previous lead intoxication with associated neurological disorders.

19. Methanol (methyl alcohol)

Methanol is used as a solvent, in denaturation of ethanol, and as raw material in the chemical industry. It has virtually the same odour and taste as ethanol. Even small doses can cause severe symptoms of intoxication (Benton 1953; Gilger 1955; Austin 1961; Cooper 1962; Kaplan 1962; Kinoshita 1964; Kane 1968; Wenzl 1968; Closs 1970; Lion 1979). The specific toxic effects of methanol usually develop after a latent period of 18-48 hour. They are: acute diminution of visual acuity with nausea, abdominal pain, vomiting, headache and dyspnoea. In many cases there is permanent diminution of visual acuity with OA, central scotoma and possibly peripheral visual field defects. Whether a chronic form of methanol intoxication exists remains to be established; if it exists, it should be exceedingly rare (Grant 1974). None of the patients examined in Suriname had had an acute diminution of visual acuity.

20. Monoamine oxidase inhibitors

Optic neuropathies with or without OA have been described in association with only three MAO inhibitors: pheniprazine, octamoxin and isoniazid. Grant (1974) lists 20 references to (usually entirely reversible) optic neuropathy associated with pheniprazine. In a few cases, however, OA developed (Jones 1961; Frandsen 1962; Simpson 1963). There are also several reports on octamoxin causing optic neuropathy, sometimes leading to partial OA (Paufique 1966; Ardouin

1967). Isoniazid has already been discussed (sub 17). It is virtually impossible that patients in the districts and in the interior of Suriname were ever treated with these antidepressants for a shorter or longer time.

21. Plasmocid

This is one of the derivatives of 8-aminoquinoline. These compounds were formerly used in the treatment of malaria. There are many reports on overdoses of plasmocid causing OA (Grant 1974) with acutely diminished visual acuity and central scotomas. In none of the patients examined in Suriname had visual acuity diminished acutely.

22. Quinine

Quinine is the oldest known antimalarial agent. It is still being used in the treatment of malaria caused by resistant Plasmodium falciparum, in myotonia congenita and in certain types of myospasm. In very large doses it was also used to provoke abortion. The most severe irreversible changes were mainly observed after excessive medication, as in the lastmentioned case. The ocular side effects of normal doses are only slight (Fraunfelder 1976). In the course of the years, many publications have described toxic effects of quinine on the eyes (Grant 1974). Optic atrophy with constricted vessels develops in a late stage in many cases. It has remained uncertain whether the OA develops as a result of direct intoxication of the optic nerve, due to arteriolar constriction, or secondary to a toxic effect of quinine on the retina. On the basis of the normal ERG and the normal appearance of the vessels in the early phase, François (1966) and Hommer (1968) concluded that the primary toxic effect is on the retinal ganglion cells or possibly the optic fibres, with secondary affection of the bipolar cells which renders the ERG subnormal. Vancea (1969) also found a normal ERG in the acute stage in most cases. The decrease in visual acuity is always acute and develops within a few hours of intoxication. None of the patients examined in Suriname had had an acute decrease in visual acuity.

23. Streptomycin

Streptomycin is still in use mainly in the treatment of tuberculosis. Ocular side effects are rare and usually reversible. Blindness with OA has been described after intrathecal administration (Bethoux 1949;

Lebas 1949), but most authors tend to ascribe the optic neuropathy to the primary affection (meningeal tuberculosis) rather than to the streptomycin used (Hermans 1972). There may be a cumulative effect in aged patients with cardiorenal lesions, which may lead to optic neuropathy (Hermans 1972). The principal side effects of streptomycin are otological (dizziness, disturbed equilibrium, hearing loss). None of the patients examined in Suriname had ever been intensively treated for tuberculosis, and in no case did neurological examination reveal distinct disorders of equilibrium.

24. Sulphonamides

Sulphonamide compounds are used in the treatment of nocardiosis, toxoplasmosis, acute urinary infections and leprosy. The principal side effects are hypersensitivity reactions, renal lesions and agranulocytosis. Ocular side effects are generally rare and reversible (Fraunfelder 1976). Transient myopia is the most common ocular side effect (Walsh 1978). Reports on optic neuropathies are sporadic (Taub 1955; Grant 1974; Pinckers 1975), and there are no indications that OA can be related to sulphonamide intoxication (Grant 1974).

25. Thallium

Many insecticides and pesticides contain thallium, and a depilatory used in the past also contained the heavy metal. Thallium intoxication is accompanied by gastrointestinal disorders, painful sensory polyneuritis of the lower limbs, loss of strength or even paralysis, loss of hair, mental disturbances, decreased visual acuity and, in a limited number of cases, death due to respiratory and circulatory disorders (Grant 1974). Grant also cites many publications which indicate that optic neuropathy (including OA) mainly develops in chronic thallium intoxication. In the patients examined in Suriname, chronic thallium intoxication could not be excluded on the basis of the clinical symptoms. Even in the case of proven thallium poisoning, ophthalmological symptoms may be minimal (Pinckers 1975). Anamnestically, however, there were no indications of any prolonged use of pesticides in the populations studied.

26. Tobacco

Tobacco optic neuropathy (also known as tobacco-alcohol amblyopia) is still a controversial clinical entity, although the term has been in use for about 150 years (Mackenzie 1830). A causal relation be-

tween smoking and optic neuropathy has never been proven (U.S. Surgeon General 1964; Potts 1973), and the discussion about the existence or non-existence of tobacco optic neuropathy still continues. Opponents point out marked discrepancies in the literature (Silvette 1960; Potts 1973) and forward the following arguments:

a. absence of any relation between the amount of tobacco smoked and the severity of illness;
b. absence of any relation between the nicotine content of the tobacco smoked and the severity of illness;
c. absence of any relation between the years of smoking and the severity of illness;
d. presence of the same pathology in non-smokers;
e. decrease in the incidence of this pathology despite an enormous increase in smoking;
f. controversial evidence of any therapeutic effect of discontinuation of smoking.

The advocates of the existence of tobacco optic neuropathy regard it as, at least in part, a nutritional deficiency disease (Carroll 1937, 1944; Foulds 1970, 1974), in which visual acuity can be improved by improving the patient's nutritional condition.

The pathology is described as a decrease in visual acuity which can be subacute (within a few days) to very gradual (a few months) (Silvette 1960), with bilateral, virtually symmetrical relative centrocaecal scotomas more pronounced for red and green than for white light. The peripheral visual fields remain intact. The patients are generally elderly pipe-smoking men with a diet deficient in proteins and vitamins B; many patients are suffering from pernicious anaemia with disturbed vitamin B_{12} absorption. Alcohol consumption is an inconstant factor in these patients, and absent in many cases (Foulds 1974; Glaser 1978).

There are no clinical differences between 'tobacco amblyopia', 'tobacco-alcohol optic neuropathy' and 'nutritional deficiency amblyopia' (Glaser 1978). Nutritional deficiency is the only constant factor in all these affections.

Foulds and other authors have reasons to assume that the toxicity of tobacco is caused by the cyanide contained in it. Analyses have shown that the cyanide content of tobacco smoke is 1500 times the maximum tolerable dose in industry (U.S. Surgeon General 1964). These investigators are convinced that the toxicity of tobacco and

that of nutrients containing cyanide is caused by a disorder of the sulphur metabolism which interferes with the normal detoxication of cyanide to thiocyanate (Foulds 1974; Brontë-Stewart 1976). Other, noxious detoxication products are released as a result (see 10).

Of the patients examined in the field study, one had been a heavy smoker until recently. A few others smoked about 10 cigarettes per day. The vast majority of the patients were non-smokers (see chapter VIII), and smoking can therefore not have played a significant role in the aetiology of the OA studied.

27. Trichloroethylene

Trichloroethylene is widely used in industry as a solvent in detergents. In the past it was used as an inhalation anaesthetic. Trichloroethylene per se is not toxic but, in contact with bases, heat, light or metal powder, the fluid is readily degraded to toxic products (Grant 1974). Acute changes develop after a latent period of a few hours. The nerves most commonly affected are the trigeminal nerve and the oculomotor nerve. In a few cases, diminished visual acuity with constriction of peripheral visual fields and optic atrophy have been described. These cranial nerve lesions were never found in patients examined in Suriname; nor did they show acutely decreased visual acuity.

V. Hereditary forms

Simple mendelian hereditary transmission was not found to be involved in any of the families studies (chapter IX). X-chromosomal transmission can be excluded from the start, and simple autosomal transmission was not demonstrable. This section considers the question whether the cases of OA examined in Suriname can be consistent with any of the hereditary forms of OA mentioned in chapter III.

1. Autosomal dominant optic atrophy (infantile, possibly sometimes congenital)

This is a classical example of autosomal dominant transmission with virtually 100% penetrance. Visual acuity can range from subnormal to < 0.1, but is usually between 0.3 and 0.1 (Grützner 1963; Jaeger 1978). This type of OA is usually detected between age 2 and age 4 (Kjer 1959, 1972; Jaeger 1978). The decrease in visual acuity takes

a very gradual course over the years, and the patients often do not complain until a more advanced age (Kjer 1959, 1972; Grützner 1962, 1963, 1965; Jaeger 1978). There are often sieve-like scotomas between the fixation point and the blind spot (Aulhorn 1973). Recently it has been suggested on the basis of histopathologic studies that autosomal dominant optic atrophy might be a primary degeneration of retinal ganglion cells (Johnston 1979).

The colour vision tests and the electro-ophthalmological and fluorescence-angiographic findings in this condition have been discussed in chapter II.

In the family study in Suriname, many children were ophthalmoscopically examined (chapter IX), but virtually no optic neuropathy was found. Moreover, only one pure blue-yellow defect was found. The group of 'random patients' mostly showed a combination of a blue-yellow with a red-green defect, and the patients in the pedigree study mostly showed red-green defects. In view of these findings, and because simple mendelian transmission was not demonstrable, it is unlikely that this form of OA was involved in these cases.

2. Optic atrophy with deafmutism (autosomal dominant)

This is a rarely described condition (Gernet 1963; Michal 1968; Koningsmark 1974; Deutman 1978). This OA is associated with total pallor of the optic disc, sensorineural deafness, mutism and deutan-type colour vision defects (Deutman 1978). Visual acuity is usually still fair (about 0.5). In the patients examined in Suriname we found no deafmutism but only some slight sensorineural hearing loss for high tones (probably presbycusis).

3. Autosomal recessive optic atrophy (congenital or early juvenile)

This relatively rare form of OA usually is present before age 3 and in over 50% of cases affects children from a consanguineous marriage (François 1978). It is a bilateral OA with total pallor of the optic disc. Visual acuity is generally very low, and sometimes the patient is blind. Nystagmus is often present. Systemic and neurological disorders are rare (François 1961, 1978). None of the patients examined in Suriname showed OA at an early age; nearly all cases were characterized by temporal pallor of the optic disc, and visual acuity was still fair in many cases.

4. Behr's complicated optic atrophy (autosomal recessive)

This syndrome becomes manifest between age 1 and age 9 and is characterized by bilateral temporal OA without progression, with nystagmus in many cases. Visual acuity is usually about 0.1, with a central scotoma and intact peripheral visual fields (Henkes 1972; François 1978). Patients with normal visual acuity have also been described (Franceschetti 1966). In addition there are several neurological symptoms (symmetrically increased tendon reflexes, positive Babinski sign, disturbed coordination with slight ataxia, a spastic gait and a positive Romberg sign), and there is a degree of psychomotor retardation which usually shows some improvement in the course of life (Franceschetti 1968; François 1978). None of the patients examined in Suriname showed the above described neurological disorders, and the age at onset of OA also excludes this form.

5. Optico-oto-diabetic syndrome (Wolfram's syndrome)

The transmission of this syndrome is probably autosomal recessive (François 1978). It involves bilateral OA which usually develops before age 15 and rarely over age 24, juvenile diabetes mellitus, diabetes insipidus and progressive sensorineural deafness (Wolfram 1938; Niemeyer 1972; Cremers 1977; François 1978; Legein 1978). Others anomalies have also been described in association with this syndrome (Cremers 1977; François 1978; Legein 1978). None of the patients examined in Suriname showed juvenile diabetes mellitus, diabetes insipidus or distinct sensorineural hearing loss.

6. Leber's disease

The mode of transmission of Leber's disease has not yet been fully explained. It has characteristics of X-chromosomal transmission: 50% of the sons of female carriers are affected, at least 50% (Lundsgaard 1944) to 95% (Kitashima 1930, Rønne 1944; Jaeger 1978) of the daughters of female carriers are themselves carriers, and there is never transmission from an affected male to his sons. On the other hand, there are virtually no reports of transmission from affected males to their daughters or from daughters of affected males to their children (Went 1972; Jaeger 1978). The disease occurs mostly in males aged 15-30 (Van Senus 1963; Went 1972; Jaeger 1978). Visual acuity shows an acute to subacute decrease, with in the early stage peripapillary telangiectases of the capillaries with slight swelling of the peripapillary nerve fibre layer (Nikoskelainen 1977).

Both eyes are affected simultaneously in 43% of cases, but intervals of 1-6 months have been described. OA develops, with in most cases total pallor of the optic disc, a large central scotoma and deutantype colour vision defects. The fluorescence-angiographic findings have been described in chapter II. Neurological disorders have been frequently mentioned also (Went 1966; De Weerdt 1969, 1971). The findings of the family study and the mode and age of onset exclude this form of OA in the patients examined in Suriname.

7. X-linked optic atrophy

This is a rarely described form of OA (Lysen 1947; Völker-Dieben 1974), which develops in childhood and takes a slow progressive course. Visual acuity is 0.02-0.4; peripheral visual fields are normal but the blind spot is enlarged. Older patients have a central or a paracentral scotoma. Colour vision shows non-specific defects. Slight neurological disorders are sometimes found (Völker-Dieben 1974). The age at onset (rarely in childhood) and the findings of the pedigree study (male: female ratio 1:1, transmission from affected males to their sons) exclude this form of OA in the patients examined in Suriname.

8. Optic atrophy in other hereditary diseases

Optic atrophy can occur in heredofamilial degenerative diseases of the CNS, heredofamilial skeletal anomalies and other hereditary diseases but these diseases (with the exception of glucose-6-phosphate dehydrogenase deficiency) will not be discussed here because the neurological and general pathology in these diseases is usually so pronounced that they cannot play a role in the differential diagnosis of possible aetiological factors in the OA types studied in Suriname. Walsh & Hoyt (1969), Krill (1972), Sachsenweger (1972), Deutman (1977) and McKusick (1978) have listed and briefly discussed these diseases.

9. Glucose-6-phosphate dehydrogenase deficiency

This is a hereditary enzymatic deficiency disease linked to the X-chromosome. Optic atrophies described in this disease develop after acute or subacute decrease in visual acuity following one or several haemolytic crises (Escobar 1964; Walsh & Hoyt 1969). The present view is that the OA in this disease is caused by the haemolytic crises and is not a direct expression of the abnormal gene (Warburg 1977).

MacKenzie (1968) determined glucose-6-phosphate dehydrogenase activities in all his patients with so-called Jamaican amblyopia, and found normal values in all.

In the Rotterdam Eye Hospital, two negroid patients were seen (West Africa and Suriname) who had optic atrophy and glucose-6-phosphate dehydrogenase deficiency but no history of haemolytic crises (Wijngaarde 1979: personal communication).

The patients examined in Suriname always showed a very gradual decrease in visual acuity and never had a history of haemolytic crises. Moreover, X-linked transmission in the families studied was excluded (chapter IX).

VI. Traumatic aetiology

Every patient in the retrospective or in the field study who was known to have sustained any severe traumatic injury in the course of life, was classified under the heading 'explained OA'. In some of these cases the OA may not have been caused by the injury, but in any case this procedure obviates the need to take into account a traumatic aetiology in the search for aetiological data on unexplained and suspected (unexplained) OA.

VII. Inflammatory aetiology

1. Inflammation of adjacent tissues

Intraocular, orbital and meningeal inflammations and septicaemias which can cause OA take such a fulminant course that they cannot be overlooked in the history. None of the patients examined reported ever to have had a severe inflammation of the eye or structures adjacent to the eye. Acute or chronic inflammation of one of the paranasal sinuses, however, could not be anamnestically excluded. The current view, however, is that sinusitis only rarely leads to optic neuropathy (Tarkanen 1971; Glaser 1978).

2. Specific infections

a. Syphilis. A study of Suriname school children by Menke & Niemel (1977) revealed that, in the district on which the study focused, 14.9% of the children between age 11 and age 15 showed a positive

VDRL reaction. Non-venereal treponemoses proved to be involved in all these cases. It is highly likely that the percentage of non-venereal treponemoses (e.g. yaws or pinta) is even larger in adults. The percentage of patients with a positive serology found in the field study is therefore smaller than might be expected, if only in view of the non-venereal treponemoses (5.3% in group B). In Suriname, syphilis occurs chiefly in Paramaribo city and only sporadically in the rural districts (Menke 1977). Nearly all the patients I examined came from plantations in the rural districts.

It is difficult to estimate the incidence of syphilis in Suriname, because several doctors in peripheral areas of Suriname ignore the rules on notification. The annual number of new patients registered at the out-patient clinic of the Dermatological Service in Paramaribo city is about 4.000. The clinic treats venereal diseases free of charge. Over the period 1973 through 1976, the annual number of patients with incipient syphilis averaged 101 (Menke 1977). Yaws is endemic in Suriname (Gentle 1962).

Lesions of the CNS and the cardiovascular system are believed not to occur in endemic treponemoses such as yaws. In a careful study of yaws patients, Lawton Smith et al. (1971) did find (sporadic) subclinical lesions of the CNS, but the correlation between these lesions and yaws has not been established with certainty.

The above indicates that syphilis cannot play a significant role as a possible factor in the aetiology of the optic neuropathies in the patients examined by me.

b. Tuberculosis. Optic atrophy has been observed only in severe meningeal tuberculosis (Walsh & Hoyt 1969). None of the patients examined in Suriname had ever had this disease.

VIII. Metabolic aetiology

1. Vitamin B complex deficiency

Several vitamins of the B complex have been related to optic neuropathy, almost exclusively on the basis of epidemiological and therapeutic data (Dekking 1947; Beam 1947; Morrees 1948, and many others referred to by Cogan [1966] and Walsh & Hoyt [1969]). The so-called 'camp eyes' described after World War II in concentration camps in the Far East involved a subacute decrease in visual acuity

which often led to OA, with sometimes beriberi and paraesthesias (Rodger 1952).

Beriberi and pellagra occur only sporadically in Suriname, but rhagades and cheilosis, caused by vitamin B_2 deficiency, are regularly observed, mainly in Bush Negroes. It has only relatively recently been assumed that vitamin B_{12} plays a role in myelin turnover and that deficiency of this vitamin can cause, not only macrocytic anaemia but also demyelination (Herbert 1965). The role possibly played by vitamin B_{12} in the detoxification of cyanide has been discussed in subsection IV.10 of this chapter.

To summarize: most authors agree that 'nutritional amblyopia' is caused by a deficiency of one or several vitamins of the B complex. The question which of these vitamins plays the principal role in this respect, however, is still controversial. It is more likely a complex of factors than a single vitamin that is responsible (Rodger 1969). The diet of the populations studied in Suriname is not conspicuously poor in products containing vitamin B (chapter X). There was no evidence of beriberi, pellagra, rhagades or cheilosis in the patients examined. Moreover, the decrease in visual acuity was always very gradual, whereas reports on 'nutritional amblyopia' always mention acute to subacute diminution of visual acuity.

However, several patients with slight paraesthesias of the limbs were in fact seen. But there was no serious deficiency in the intake of the various components of the vitamin B group, and more specifically vitamin B_{12}. The serum concentrations of these vitamins were not determined and consequently the possibility of a low serum vitamin B level (e.g. due to malabsorption) cannot be excluded.

2. Protein deficiency

The extent to which protein deficiencies could cause OA is obscure. These deficiencies are often associated with vitamin deficiency. There are indications that protein deficiencies, especially during the growth period, exert a negative influence on development and function of the CNS (Birch 1972; Milkie 1973). Moreover, there is a relation between proteins and various vitamins of the B complex in that a high-protein diet increases the vitamin B_2 and B_6 requirements, and in that the organism can produce nicotinic acid from the essential animo acid tryptophan (De Wijn 1973). There are indications, moreover, that protein deficiencies can lead to inadequate levels of sulphurated amino acids, and this has its implications for the detoxification of cyanide

(Pettigrew 1972; Brontë-Stewart 1976). Some authors hold that transient tryptophan deficiency in the diet can give rise to severe retrobulbar neuropathy (Jaeger 1978).

The diet of the populations studied showed no distinct protein deficiencies (see chapter X), but possible deficiencies in certain sulphurated amino acids such as cystine, cysteine and methionine, cannot be excluded.

3. Diabetes mellitus

It has so far remained uncertain whether a metabolic relation exists between diabetes mellitus and OA (Cogan 1966; Glaser 1978). In juvenile diabetes mellitus there may be such a relation, but in these cases the OA is often associated with other anomalies and therefore possibly not of diabetic origin (Duke Elder 1971). In many cases the optic neuropathy is based on vascular pathology. The persons examined in the field study included only one patient with (mature-onset) diabetes mellitus.

4. Pernicious anaemia

Some patients with pernicious anaemia develop an optic neuropathy (Freeman 1961; Smith 1961). Moreover, some of the patients with so-called 'tobacco-alcohol amblyopia' (16% according to Foulds) have pernicious anaemia (Foulds 1969; Brontë-Stewart 1976; Glaser 1978). In these cases visual acuity is acutely to subacutely diminished. and OA develops unless therapy is instituted in due time; this is usually associated with combined degeneration of the spinal cord. The neurological disorders are caused by, among other factors, disturbed myelin synthesis caused by vitamin B_{12} deficiency (Herbert 1965).

Our patients were not haematologically examined, and pernicious anaemia can therefore not be entirely excluded. None of the patients, however, showed the complete symptomatology of combined degeneration of the spinal cord. And these neurological disorders are a much more constant feature in pernicious anaemia than optic neuropathies. Moreover, the decrease in visual acuity in these patients was neither acute nor subacute. In view of the clinical syndrome, therefore, it is exceedingly unlikely that pernicious anaemia played a role of any significance in the forms of OA studied.

5. Endocrine disorders

Optic neuropathies can develop in the case of dysthyroidism, with

excessive congestion of orbital and periorbital structures (Cogan 1966). In view of echographic and CT-scan findings, it is very likely that the swollen muscles in the apex of the orbit compress the optic nerve (Glaser 1978) and that the metabolic pathology is not the primary cause underlying the OA.

There are indications of a relation between OA and pregnancy/lactation (Walsh & Hoyt 1969; Duke Elder 1971). However, no evidence has ever been presented to show that a primary metabolic factor rather than tumour growth or enlargement (Enoksson 1961; Lepoire 1964) is the cause.

6. Metabolic storage diseases

These diseases include sphingolipidoses, mucopolysaccharidoses, mucolipidoses and lysosomal enzyme deficiencies, all of which take a progressive neurodegenerative course. The optic atrophy which often develops in these conditions results from the presence of abnormal storage products in the retina (e.g. in the ganglion cells in Tay-Sachs disease) or in the optic nerve proper (Glaser 1978). This group plays no role in the differential diagnoses of the optic atrophies studied, because the patients examined in Suriname showed no severe neurological disorders.

IX. Systemic non-infectious diseases

1. Sarcoidosis

In rare cases, OA can develop as a result of sarcoids in and around the optic nerve (Laties 1972; Jampol 1972; Gass 1973) or intracranial sarcoids (Blain 1965). It has also been suggested that perineuritis due to an inflammatory reaction of the sheaths of the optic nerve can play a role in this respect (Duke Elder 1971). In all these cases there is subacute or rapidly progressive diminution of visual acuity in one or both eyes (Glaser 1978). The patients examined in Suriname showed no ophthalmological evidence of ocular sarcoidosis such as anterior or posterior uveitis, sarcoids in the iris, retinal periphlebitis or chorioretinitis.

2. Sickle-cell anaemia

Optic neuropathies are rare in sickle-cell anaemia (Welch 1966), but an ischaemic optic neuropathy can develop as a result of haemolytic crises.

None of the patients examined in Suriname showed retinal lesions consistent with sickle-cell anaemia such as tortuosity of the veins, vascular occlusions, round retinal scars (black sunburst sign) or vascular proliferations (sea-fan sign). Nor was there any anamnestic evidence of haemolytic crises in the past.

3. Collagen diseases

Collagen diseases which can cause OA are mainly: temporal arteritis, polyarteritis nodosa and Takayasu's disease (pulseless disease). The optic neuropathy in these cases is always ischaemic (Walsh & Hoyt 1969; Jacobiec 1978). These conditions have been discussed in the subsection on vascular causes of OA.

X. Tapetoretinal and neuroretinal degenerations

Every patient in the groups of unexplained OA and suspected OA was given an extensive ophthalmoscopic examination. This did not reveal the wax pallor of the optic disc, the pigmentations and the narrow, straightened vessels that can be found in rod-cone dystrophy (retinitis pigmentosa). The age of onset excludes Leber's congenital amaurosis. The male: female ratio of OA was 1:1, which rules out sex-linked juvenile retinoschisis.

Certain dystrophies of the posterior pole which cause only very slight changes in fundo, such as dominant foveal dystrophy and progressive cone dystrophy (Deutman 1971), cannot be entirely ruled out on the basis of the ophthalmoscopic findings. These conditions, however, involve only very slight temporal pallor of the optic disc, and could therefore be of importance only in patients with suspected OA.

The patients examined in Suriname only sporadically showed an absolute central scotoma, and never achromatopsia. It is therefore highly unlikely that any of these diseases was involved here. The other tapetoretinal and neuroretinal degenerations are rarely associated with OA (Deutman 1971, 1977, Sachsenweger 1972).

4. Some comparable optic neuropathies

As early as 1645, Jacob Bontius described decreased visual acuity

and blindness in seamen sailing to the Far East (Crews 1963). The symptoms often disappeared when the diet was improved. In the past hundred years, there have been numerous reports on optic neuropathies with or without associated neurological disorders. Several articles reviewing the pertinent literature have already been mentioned.

Optic neuropathies without other neurological disorders are probably most common (Montgomery 1964). Today, these endemic optic neuropathies are reported mainly in West Africa and Jamaica. In the English literature we could trace only two publications which mention this pathology in the Northern part of the South American continent (Browne 1939; Murray 1959).

A look at the literature on optic neuropathies in the tropics shows that, despite general similarities in ocular pathology, there are marked differences in the associated non-ocular pathology described. The question arises whether the many publications describe the same pathology with slight variations in symptomatology, or conditions of entirely different aetiology in which OA can develop.

a. 'camp eyes'

A relatively well-defined form of OA is found in the so-called 'camp eyes'. Immediately after World War II, many authors described them in white males who had been in Japanese POW camps. The aetiology of this condition has never been established with certainty. Although general nutritional deficiencies were involved, most authors postulate that deficiency in various B vitamins explains this pathology. The visual field defects observed were erratic central and paracentral scotomas (Dekking 1947; Moorrees 1947), which showed no similarity to the centrocaecal scotomas described in tobacco-alcohol optic neuropathy.

Most of these patients showed an acute to subacute diminution of visual acuity (Dekking 1947; Moorrees 1947; Quéré 1967). They complained of 'fragmented vision', showed small central visual field defects and often had to scan in order to perceive the entire central visual field. A regular and fairly specific finding was that visual acuity was significantly better in subdued light than in full daylight (fig. XI-1).

Many patients also complained of paraesthesias of the lower limbs (so-called burning feet syndrome). Glossitis, perlèche and cheilosis were other regular findings, but pellegra was virtually absent. Beriberi in these patients was a controversial subject: Dekking (1947) and Moorrees (1947) held that beriberi was virtually absent in this group,

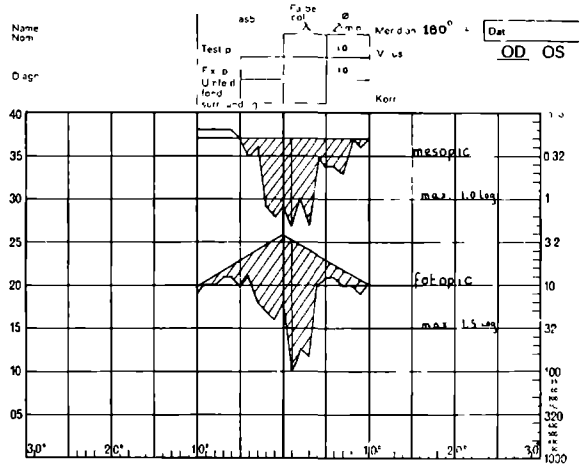

FIG. XI-1. Static perimetry (mesopic and photopic) in a patient with 'camp eyes' examined in Nijmegen.

but Rodger (1952) contended that a relation existed between beriberi and these optic neuropathies.

In the early stage, several authors described slight papilloedema, congestion of the retinal vessels and small retinal haemorrhages (Dekking 1947). The optic disc usually showed slight pallor. Some authors believed that the primary condition was localized in the retina (Dekking 1947; Moorrees 1947).

We recently saw a few patients with 'camp eyes' at the Ophthalmological Department in Nijmegen. These patients showed slight changes of the retinal epithelium and some pallor of the temporal part of the optic disc. On fluorescein angiography we found discrete areas of hyperfluorescence in the macular region and some mild hypofluorescence of the optic discs. The ERG was subnormal, and the VECP gave in some cases very low responses. The EOG was normal. The colour vision tests showed disturbed blue-yellow and red-green discrimination. When examined with the Amsler chart there appeared to be multiple small paracentral scotomas.

In the patients examined in Suriname, both the onset and the clinical features of the OA differed totally from those described in patients with camp eyes. The latter may therefore be assumed to be an entirely different entity.

b. Optic atrophy in Jamaica and West Africa

Table XI-1 lists the principal recent publications describing OA

TABLE XI-1. Publications on optic neuropathies in West Africa and Jamaica.

Year	Author	Country	Bilateral	Optic disc	Visual acuity	Visual fields	Colour vision	Onset	Sex	Race
1956	Degazon	Jamaica	yes	p & tp	≦0.2-0.3	c.scot. pc.scot. pl	?	gradual	m = f	N
1962	Behrman	Jamaica	yes	p & tp	>0.02 <0.3	c.scot. pl	severely disturbed	acute to subacute	m = f	N
1963	Crews	Jamaica	yes	tp	≦0.2-0.3	c.scot. p.a.sc. (pl)	?	gradual	m > f	N
1964	Montgomery	Jamaica	yes	tp	?	c.scot. pc.scot. pl	?	gradual (months)	m = f	N
1966	Owen	Jamaica	yes	tp	>0.06 ≦0.3	c.scot. cc.scot.	?	probably gradual	m = f	N
1968	Mackenzie	Jamaica	yes	p	≦0.3	marked variations	?	?	m > f	N
1971	Carrol	Jamaica	yes	tp	≦0.2	c.scot. cc.scot. pc.scot.	?	acute to subacute	m = f	N
1966	Monekosso	Nigeria	yes	p	?	?	?	?	m > f	N
1967	Quéré	Sénégal	yes	p	≦0.1	c.scot. cc.scot.	several defects	acute	m ⩾ f	N
1968[a]	Osuntokun	Nigeria	yes	p & tp	<0.1-0.3	pl	?	gradual	m = f	N
1968[b]	Osuntokun	Nigeria	yes	p	<0.1-0.3	pl	?	acute and gradual	m = f	N

p = pallor of optic disc
tp = temporal pallor of optic disc
c.scot. = central scotoma
cc.scot. = centrocaecal scotoma

eurological isorders	Aetiology	Age at onset	Remarks
	toxic factors	?	- female age of onset higher than male - no nutritional deficiencies
one	?	29	- African race predisposed to this abnormality
sensorineural deafness diminished tendon reflex	?	24	- no nutritional deficiencies
spastic paraplegia posterior column pathology in 50% sensory ataxia in 10%	neurosyphilis? toxins? vitamin deficiency?	20-30	- optic atrophy mainly in sensory ataxia - optic atrophy and sensorineural deafness sporadically in spastic paraplegia - pernicious anaemia in 30% of patients - occurs in all social classes
one	nutritional deficiency in childhood	< 20	- many children with nutritional deficiencies
one	cyanide?	?	- no G-6-PD deficiency - no vitamin B_{12} deficiency
sensorineural deafness in 10%	?	15-18	
sensorineural deafness sensory abnormalities and spastic paresis of legs	cyanide?	?	- probably also protein and vitamin deficiency, but no vitamin B_{12} deficiency
sometimes sensorimotor polyneuropathy	- malnutrition in 75% - deficiency in vitamin B complex except thiamine	about 20	- mainly in poor population groups - neurological disorders mainly in women aged 40 and over
sensorineural deafness sensory ataxia absent tendon reflex	cyanide from cassava?	20-39	- no malnutrition - mainly in poor population groups - mucocutaneous signs of ariboflavinosis in one-third of patients
sensorineural deafness sensory ataxia	cyanide from cassava?	40	- low concentration of sulphurated amino acids in plasma - total protein and vitamin contents normal to high - mainly in poor population groups

pc.scot. = paracentral scotoma
pl = peripheral limitations
p.a.sc. = partial annular scotoma

in Jamaica and West Africa. Three different syndromes are distinguishable:

Optic atrophy with sensory ataxia.
Optic atrophy with spastic paraplegia.
Optic atrophy without neurological disorders.

Optic atrophy with spastic paraplegia has been mainly described in Jamaica, whereas the non-spastic atactic syndrome is more common in Nigeria (Monekosso 1966; Montgomery 1964).

Several authors have related the neuropathies observed in West Africa to the cyanide content of the diet (Monekosso 1966; McKenzie 1968; Osuntokun 1968). Since conditions for genealogical research in West Africa are likewise very difficult, no conclusions have so far been formed concerning possible hereditary factors.

The impression is strong, however, that OA is largely confined to populations in which consanguineous relationships are not uncommon (Diallo 1979: personal communication).

The relative incidences of the various forms of OA in Jamaica have changed in the course of the years, for in 1897 and in 1918 mention was made of large groups of patients with mainly an atactic polyneuropathy with OA and bilateral deafness (Osuntokun 1968). In the past few decades, optic atrophy without neurological disorders has been most frequently described in Jamaica (Degazon 1956; Behrman 1962; Owen 1966; McKenzie 1968). In Africa, too, this was regarded as an important ophthalmological problem well into the Fifties (Montgomery 1964). The various publications show that a neurological evaluation was usually carried out.

The patients examined in Suriname regularly showed very slight neurological disorders (chapter VIII), but ataxia and spastic paraplegia were certainly not observed. The forms of OA found in Suriname are therefore most readily comparable to the optic atrophies without neurological disorders mentioned under C. Clinically, however, the OA found in Suriname differs from the OA without neurological disorders found in Jamaica on two important points:

In Jamaica, the age at onset averages 20, whereas in Suriname it is between 30 and 50.

Some publications describe acute to subacute diminution of visual acuity in Jamaica, whereas in Suriname the decrease in visual acuity

was always very gradual. It is highly plausible that an acute to subacute decrease in visual acuity is based on a pathology entirely different from that which underlies optic neuropathies with a very gradual decrease in visual acuity.

The data now available therefore warrant the conclusion that, besides the optic atrophies described in Jamaica and in West Africa, there exists a different form of optic atrophy in Suriname (in Creoles and Bush Negroes).

Whether these different diseases involve identical aetiological factors has yet to be established.

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SUMMARY AND CONCLUSIONS

A retrospective case record study and a field study were devoted to the occurrence, forms and aetiology of optic atrophy in Suriname from 1974 to medio 1977.

Optic atrophy is quite common in Suriname. At the out-patient clinic of the Academic Hospital in Paramaribo city, diagnoses of optic atrophy were made in 2360 Creoles, 441 Bush Negroes, 830 Hindustani and 122 representatives of other population groups during the period 1950-1976.

The optic atrophy could be explained in 12.6% of the Creole, 13.1% of the Bush Negro, 26.5% of the Hindustani and 39.6% of the 'other' patients. There remained a group of patients with bilateral unexplained optic atrophy and a group with bilateral suspected optic atrophy. Bilateral unexplained optic atrophy existed in 58.8% of the Creole, 66.7% of the Bush Negro and 36.0% of the Hindustani patients. The corresponding values for bilateral suspected optic atrophy were 21.0%, 13.6% and 29.4%, respectively.

Bilateral unexplained optic atrophy was more common in Creoles and Bush Negroes than in Hindustani. It was only sporadically observed in the other population groups. Its incidence was highest in the Para and Saramacca districts, and was found as often in males as in females.

The incidence of bilateral unexplained optic atrophy diminished in the course of time in Creoles, possibly increased in Bush Negroes and since 1963 has remained virtually unchanged in the Hindustani. Nearly all patients developed an optic neuropathy characterized by temporal pallor of the optic disc.

The retrospective study revealed that the vast majority of case records mentioned no retinal lesions. The field study regularly disclosed very slight pigment changes in the macular region, and some arterial constriction.

Visual acuity was found to vary widely within a given optic atrophy group. It was < 0.1 in about 25% and < 0.5 in about 50% of the Creole patients with bilateral unexplained optic atrophy, the corresponding percentages in Bush Negroes being 40 and 70, respectively. Of all patients with bilateral unexplained optic atrophy in the retrospective

study, it was found that 13% could be regarded as socially blind (VODS ≤ 0.05).

Visual field defects were found in virtually all personally examined patients with bilateral unexplained optic atrophy, and in 75% of those with suspected optic atrophy. An entirely specific visual field defect, however, was not identified. Most patients showed a combination of diminished general sensitivity with paracentral or central absolute and/or relative scotomas and variable peripheral defects as well as an enlarged blind spot.

No distinctly pathological pupillary reactions were observed.

No increased intraocular pressure was found in bilateral unexplained and bilateral suspected optic atrophy. Colour vision defects were found in 41% of the group random patients with bilateral optic atrophy. Of these patients, 27% showed a combined red-green and blue-yellow defect, while 13% showed a pure red-green defect. The latter was also found in 14% of the pedigree study patients. Combined red-green and blue-yellow defects were not found in this group. Only one of the patients in this group showed a pure blue-yellow defect.

Bilateral unexplained optic atrophy occurs more frequently with increasing age. A marked increase in the number of patients was observed at about age 40. The onset of ocular symptoms was between age 30 and age 50 in over 50% of the patients. All showed a gradual decrease in visual acuity.

This bilateral optic atrophy found in Suriname differs from the comparable optic atrophy described in Jamaica and West Africa, e.g. in age at onset and in manner of development.

The clinical findings of the field study were tested on the basis of a personal classification of optic atrophy.

On the basis of clinical symptoms, serological findings and anamnestic data, many neurological, neuroretinal and infectious (specifically syphilis) causes were excluded. Several vascular and hereditary causes of optic atrophy proved not to play an aetiological role in the patients considered. Most intoxications, too, were excluded. It was demonstrated that the nutritional cyanide intake in various cassava products is significant in the populations studied. In view of the results of the nutrition study, it is improbable that the Creole population considered has distinct vitamin and protein deficiencies.

The nutrition of the Indian groups studied also contained many cyanogenetic ingredients. In this population, however, virtually no optic

atrophy was found. This indicates that there is no simple relation between cyanide intake and optic atrophy. In terms of vitamin and protein intake, too, no marked differences were demonstrable between the Indian and the Creole population groups.

Familial occurrence of this pathology was established in the Creole population group studied in the Para district. X-linked hereditary transmission was excluded in the families examined, and autosomal dominant or recessive transmission was neither demonstrated nor excluded with certainty. The findings obtained in the pedigree study therefore warrant no definite conclusion concerning heredity, if any.

The incidence observed in the course of the years suggests that an exogenous factor is very likely to play a role in this optic atrophy. The cyanide contained in the diet was the only factor of significance I could identify, but this factor cannot be the sole cause of the pathology observed (the diet of the Indian population groups contains equal amounts of cyanide). It is therefore possible that the negroid population groups in Suriname have a hereditary predisposition to optic atrophy. Perhaps optic atrophy develops only when this hereditary factor is present and in addition the exogenous factor exists in the form of, say, toxic influences and/or deficiencies.

On the basis of this study, the design and scope of which were limited by the circumstances, neither tentative nor definite conclusions can be formulated on this point. Since the role of cassava as a staple food will continue to be prominent in tropical regions, reliable data on the toxicity of cassava and its produtes (if improperly prepared) will have to be obtained.

Further research in optic atrophy is recommendable in Suriname. This research should focus in particular on the Bush Negroes, because it has been demonstrated that the incidence of optic atrophy is high in this population groups, is certainly not decreasing and is possibly even on the increase.

More heredity studies should be carried out, if possible. Exact analyses of the various serum vitamin levels (including vitamin B_{12}) are also required. The sulphurated amino acid contents of the diet and the serum should be determined, and the same applies to the glutathione content of the erythrocytes and the thiocyanate content of serum and urine, both in patients and in healthy individuals of the groups in question.

As pointed out, I found it impossible for several reasons to increase the scope of this study. However, at least 130,000 immigrants from

Suriname are now living in The Netherlands, and their numbers are still increasing. This is why I circularized all ophthalmologists in The Netherlands with the request to send data on patients from Suriname with bilateral optic atrophy (Hendrikse 1979).

It may be possible in future to present further data on the basis of findings obtained in these patients in The Netherlands.

Van 1974 tot medio 1977 werd in Suriname een retrospektief archiefonderzoek en een veldonderzoek verricht naar het voorkomen, de vorm van voorkomen en de aetiologie van opticusatrofie.

Opticusatrofie komt in Suriname veel voor.

Het aantal patienten van de polikliniek van het Academisch ziekenhuis te Paramaribo waarbij in de periode 1950-1976 opticusatrofie geconstateerd werd, bedroeg bij de Creolen 2360, bij de Bosnegers 441, bij de Hindustanen 830 en bij de andere bevolkingsgroepen tezamen 122. Een verklaring voor de opticusatrofie kon worden gevonden bij de Creolen in 12.6%, bij de Bosnegers in 13.1%, bij de Hindustanen in 26.5% en bij de overige bevolkingsgroepen in gemiddeld 39.6% van de gevallen. Er bleef over een groep patienten met een onverklaarde dubbelzijdige opticusatrofie, alsmede een groep met een beeld dat dubbelzijdig suspect was voor opticusatrofie en waarbij daarvoor ook geen verklaring kon worden gevonden. Bij de Creolen betrof het in 58.8%, bij de Bosnegers in 66.7% en bij de Hindustanen in 36.0% van de gevallen van opticusatrofie een dubbelzijdige onverklaarde opticusatrofie. Deze percentages voor de gevallen dubbelzijdig suspect voor opticusatrofie bedroegen respektievelijk 21.0, 13.6 en 29.4.

Dubbelzijdige onverklaarde opticusatrofie komt voornamelijk voor bij Creolen en Bosnegers en veel minder bij Hindustanen. Bij de overige bevolkingsgroepen komt deze vorm van opticusatrofie slechts sporadisch voor.

Het voorkomen van dubbelzijdige onverklaarde opticusatrofie is het hoogst in de districten Para en Saramacca.

Er is geen verschil in voorkomen tussen mannen en vrouwen.

Er is een afname van het voorkomen van dubbelzijdige onverklaarde opticusatrofie bij de Creolen, een mogelijke toename bij de Bosnegers, en sinds 1963 een vrijwel gelijk blijven hiervan bij de Hindustanen. Het betreft in vrijwel alle gevallen een door een temporale papilatrofie gekenmerkte opticoneuropathie.

In de grote meerderheid van de patienten van het retrospectieve archiefonderzoek werden geen retina-afwijkingen gezien. Bij het veldonderzoek werden regelmatig zeer gering pigmentalterelaties in de macula, en enigszins nauwe arteriën waargenomen.

De visus bleek binnen eenzelfde groep van opticusatrofie sterk te kunnen variëren. Van de Creoolse patienten met een dubbelzijdige

onverklaarde opticusatrofie heeft ongeveer 25% een visus lager dan 0.1 en ongeveer 50% een visus lager dan 0.5. Bij de Bosnegers zijn deze percentages respektievelijk 40 en 70. Van alle patienten uit het archiefonderzoek met dubbelzijdige onverklaarde opticusatrofie tezamen bleek 13% als maatschappelijk blind te kunnen worden beschouwd (met een dubbelzijdige visus $\leq$ 3/60).

Bij vrijwel alle persoonlijk door mij onderzochte patienten met een dubbelzijdig onverklaarde opticusatrofie en bij 75% van de patienten verdacht voor opticusatrofie werden gezichtsveldafwijkingen waargenomen. Een geheel specifiek gezichtsvelddefekt werd echter niet gevonden. Het betrof meestal een combinatie van algehele gevoeligheidsdaling met paracentrale of centrale absolute en/of relatieve scotomen met variërende perifere beperkingen en een vergrote blinde vlek.

Duidelijk pathologische pupilreakties werden niet waargenomen.

In de categorie dubbelzijdige opticusatrofie en dubbelzijdig verdacht voor opticusatrofie werd geen verhoogde intraoculaire druk gemeten. Bij de groep willekeurige patienten met dubbelzijdige opticusatrofie werd in 41% van de gevallen kleurzinstoornissen gevonden. Bij 27% van deze patienten betrof het een combinatie van een rood-groen met een blauw-geel defekt, en bij 13% een zuivere rood-groen stoornis. In de groep patienten uit het stamboomonderzoek werd bij 14% een zuiver rood-groen stoornis gevonden. Een combinatie van een rood-groen met een blauw-geel defekt werd in deze groep niet waargenomen. Bij één patient uit groep B werd een zuiver blauw-geel defekt gevonden.

Dubbelzijdige onverklaarde opticusatrofie komt vaker voor bij het stijgen van de leeftijd. Rond het 40e jaar werd een sterke toename geconstateerd van het aantal patienten. Bij meer dan 50% van de patienten waren de oogklachten ontstaan tussen het 30e en 50e jaar. In alle gevallen betrof het een geleidelijke visusdaling.

Deze in Suriname voorkomende dubbelzijdige opticusatrofie onderscheidt zich van de op Jamaica en in West Afrika beschreven vergelijkbare opticusatrofie onder meer wat betreft de leeftijd en de wijze van ontstaan.

Aan de hand van een eigen classificatie van opticusatrofie werden de klinische bevindingen van het veldonderzoek getoetst.

Op basis van het klinische beeld, serologische onderzoek, en de anamnestische gegevens konden veel neurologische, neuroretinale, en infektieuze (met name lues) oorzaken worden uitgesloten.

Verschillende vasculaire, en hereditaire oorzaken van opticusatro-

fie bleken geen aetiologische rol te kunnen spelen. Ook de meeste intoxicaties konden worden uitgesloten. Aangetoond werd dat er bij de onderzochte populaties een niet te verwaarlozen opname van cyanide bevattende bestanddelen bestaat in de vorm van verschillende cassave produkten. Op basis van het voedingsonderzoek is het niet waarschijnlijk dat er duidelijke tekorten bestaan aan vitaminen en eiwitten bij de onderzochte Creoolse populatie.

Ook de voeding van de onderzochte Indiaanse bevolkingsgroepen bevatte veel cyanide houdende bestanddelen. Bij deze populatie werden echter vrijwel geen opticusatrofiën gezien. Derhalve lijkt er geen eenvoudige relatie te kunnen bestaan tussen de cyanide intake en de opticusatrofie. Ook wat betreft het vitamine en eiwitgehalte van de voeding konden op basis van het verrichte dieetonderzoek geen grote verschillen tussen de Indiaanse en de Creoolse bevolkingsgroep worden aangetoond.

Er is sprake van een familiair voorkomen van deze pathologie bij de onderzochte Creoolse bevolkingsgroep in het district Para. Een x-chromosomaal-gebonden overerving is uitgesloten in de door mij onderzochte families, terwijl een autosomaal dominante of recessieve overerving niet kon worden aangetoond, maar ook niet met zekerheid kon worden uitgesloten. De bevindingen bij het stamboomonderzoek laten derhalve geen duidelijke conclusies toe omtrent een eventuele overerving. Het verloop van de incidence over de jaren maakt het zeer waarschijnlijk dat een uitwendige faktor een rol speelt bij deze opticusatrofie. Daar de aanwezigheid van cyanide in het dieet de enige uitwendige faktor van belang is die ik kon vinden, terwijl deze faktor alléén niet de oorzaak van de pathologie kan zijn (daar ook bij de Indiaanse bevolkingsgroepen evenveel cyanide in het dieet voorkomt) is het mogelijk dat er bij de negroïde bevolkingsgroep van Suriname een hereditaire praedispositie bestaat. Opticusatrofie zou alleen dan optreden wanneer aan deze hereditaire faktor voldaan wordt, en bovendien de exogene faktor in de vorm van bijvoorbeeld toxische momenten en/of deficienties aanwezig is. Op basis van dit onderzoek, dat door de omstandigheden noodgedwongen beperkt opgezet was, kunnen hieromtrent voorlopig nog geen definitieve conclusies worden getrokken. Daar de rol van cassave als voedingsmiddel in tropische gebieden zeker niet afneemt, zal er omtrent de giftigheid van dit gewas bij onjuiste bereiding zekerheid moeten worden verkregen.

Het verdient aanbeveling, dat er in Suriname nog verder onderzoek

op dit terrein plaatsvindt. Dit onderzoek zal zich dan vooral dienen te richten op de Bosnegers, daar aangetoond werd dat bij deze bevolkingsgroep de incidence van opticusatrofie groot is, in ieder geval niet afneemt, en mogelijk zelfs toeneemt.

Voor zover mogelijk zal nog meer erfelijkheidsonderzoek moeten worden verricht. Bovendien zullen er nauwkeurige analyses moeten plaatsvinden betreffende het gehalte aan verschillende vitamines (inclusief Vit. B_{12}), in het serum. Ook het gehalte van zwavelhoudende aminozuren in het dieet en in het serum zal moeten worden bepaald, evenals het glutathiongehalte van de erythrocyten en het thiocyanaatgehalte van serum en urine, zowel bij patienten als ook bij gezonde personen van de betreffende groepen.

Zoals reeds eerder vermeld werd, was het mij om verschillende praktische redenen onmogelijk om dit onderzoek zo uitgebreid uit te voeren. Er zijn echter thans zeker 130.000 immigranten uit Suriname in Nederland, en dit aantal neemt nog toe. Daarom werden de in Nederland werkzame oogartsen door middel van een rondschrijven verzocht gegevens betreffende Surinaamse patienten met een dubbelzijdige opticusatrofie aan ons door te geven (Hendrikse 1979).

Mogelijk zullen wij in de toekomst meer bijzonderheden kunnen vermelden aan de hand van bij deze patienten in Nederland verrichte onderzoekingen.

De 1974 à Juin 1977 des recherches rétrospectives d'archives ont été effectuées au Suriname, d'une part, tandis que, d'autre part, des examens relatifs à l'existence, aux symptomes et à l'étiologie de l'atrophie optique ont été pratiqués sur les lieux

Les cas d'atrophie du nerf optique sont fréquents au Suriname

Dans la période 1950-1976 le nombre de malades de la polyclinique du Centre Hospitalier Universitaire (C H U) à Paramaribo, chez lesquels l'atrophie optique a été constatée était 2.360 chez les Créoles, 441 chez les Marrons, 830 chez les Hindous et 122 chez l'ensemble des autres habitants du pays

Une explication de cette atrophie optique pouvait être trouvée dans 12,6% des cas chez les Créoles, dans 13,1% des cas chez les Marrons, dans 26,5% des cas chez les Hindous et dans 39,6% des cas chez les autres habitants

Il restait un groupe de malades chez lesquels l'étiologie de l'atrophie optique bilatérale demeurait inconnue, ainsi qu'un groupe montrant une image qui pourrait laisser supposer la présence d'atrophie optique, mais pour laquelle aucune explication ne pourrait être trouvée Chez les Créoles souffrant d'atrophie optique, il s'agissait dans 58,8% des cas d'atrophie optique bilatérale du segment temporal de la papille dont l'étiologie demeurait inconnue Chez les Marrons et les Hindous ce pourcentage était respectivement de 66,7 et de 36,0. Les pourcentages des cas douteux d'atrophie optique bilatérale étaient respectivement de 21,0, de 13,6 et de 29,4.

L'atrophie optique bilatérale à étiologie inconnue frappe principalement les Créoles et les Marrons, et beaucoup moins les Hindous, tandis qu'elle ne se produit que sporadiquement chez les autres habitants du pays

La présence d'atrophie optique bilatérale à étiologie inconnue est la plus importante dans les districts de Para et de Saramacca Le nombre des cas chez les hommes et chez les femmes est identique Chez les Créoles on a constaté un recul dans le temps de l'incidence de l' atrophie optique à étiologie inconnue, une augmentation probable chez les Marrons et - depuis l'année 1963 - une stabilité relative chez les Hindous

Dans la plupart des cas il s'agit d'une neuropathie optique, qui se manifeste par une atrophie bilatérale du segment temporal de la papille

Chez la plus grande partie des malades dont les dossier ont été examinés dans les archives du CHU de Paramaribo, on n'a pas relevé de déformations de la rétine.

Au cours des recherches sur les lieux on a régulièrement trouvé des cas d'altération légère du pigment dans la macule et un certain rétrécissement artériel.

A l'intérieur d'un ensemble des cas comparables d'atrophie optique la vue peut varier beaucoup d'un malade à l'autre.

Parmi les Créoles souffrant d'atrophie optique bilatérale du segment temporal de la papille on constate, dans 25% des cas, une vue inférieure à 0,1 et dans 50% des cas inférieure à 0,5.

Chez les Marrons ces pourcentages sont respectivement de 40 et de 70. 13% de la totalité des malades souffrant d'atrophie optique bilatérale du segment temporal de la papille, et enregistrés dans les archives du CHU de Paramaribo peuvent être considérés comme aveugles du point de vue de la Société (une vue de $\leq 3/60$).

On a constaté des déformations du champ visuel chez presque tout les malades examinés par moi, souffrant d'atrophie optique bilatérale du segment temporal de la papille et dans 75% des cas douteux. Néanmoins on n'a pu relever aucune déformation spécifique du champ visuel. Il s'agissait dans la plupart des cas d'une combinaison de diminution générale de la sensibilité et de scotomes centraux ou paracentraux absolus ou relatifs, ainsi que de limitations variables intervenant dans la périphérie et de taie élargie. On n'a pas constaté de réactions pathologiques particulières de la pupille.

Aucune tension intra-oculaire n'a été relevée dans la catégorie des malades souffrant d'atrophie optique bilatérale du segment temporal de la papille et dans les cas prêtant au doute.

Des perturbations de la faculté d'appréciation des couleurs ont été constatées chez 41% des malades atteints d'atrophie optique bilatérale appartenant au groupe arbitrairement choisi.

27% du nombre de ces personnes souffraient d'un trouble de la sensibilité au rouge-vert combiné à celui de bleu-jaune, tandis que 13% de ces malades présentaient un simple trouble de la sensibilité au rouge-vert.

Dans le groupe des malades dont l'arbre généalogique a pu être examiné (Groupe B) 14% souffraient d'un trouble manifeste de la sensibilité au rouge-vert, associé à celui du bleu-jaune. On a trouvé une défectuosité non-nuancée chez seulement un des malades appartenant à ce groupe.

A mesure que l'âge augmente, l'atrophie optique bilatérale du segment temporal de la papille se rencontre plus fréquemment

Vers la quarantaine le nombre de malades augmente sensiblement. Dans plus de 50% des cas les troubles oculaires ont débuté entre la 30e et la 50e année Dans tous les cas il s'agissait d'une diminution progressive de la vue

Cette forme d'atrophie optique bilatérale rencontrée au Suriname diffère notamment de celle qu'on trouve à la Jamaique et en Afrique occidentale, par l'âge et la manière dont elle se déclare. En se basant sur le syndrome clinique, sur les résultats de l'enquête sérologique et sur les données anamnétiques, on a pu éliminer beaucoup de causes neurologiques, neurorétinales et infectieuses (notamment la syphilis).

A partir d'une classification établi par moi même de l'atrophie optique, les données cliniques trouvées pendant les recherches sur le terrain ont été verifiés

Plusieurs causes d'origines vasculaire et héréditaire de l'atrophie optique n'ont pu avoir une importance étiologique

La plupart des intoxications ont pu être également éliminées Il a été démontré, que la population soumise à ces examens absorbait une quantité non-négligeable de produits alimentaires contenant du cyanure dont l'origine se trouve dans la Cassave

D'autre part l'enquête alimentaire a révélé qu'il était peu probable que la population Créole ait souffert d'une carence évidente en vitamines et en albumines.

Des composants contenant du cyanure se retrouvent également dans les produits alimentaires consommés par la partie indienne de la population soumise à l'examen. Les cas d'atrophie optique sont cependant extrêmement rares dans cette fraction de la population Il semble donc qu'il ne puisse y avoir une relation directe entre l'absorption du cyanure et l'atrophie optique

D'après les recherches relatives au régime alimentaire, il a été impossible de déceler, entre les Indiens et les Créoles, des différences sensibles dans la teneur en vitamines et en albumines dans l'alimentation

On a pu constater en outre que cet état pathologique se rencontrait dans le milieu familial Créole, examiné dans le district de Para. Une hérédité x-chromosomique est exclue chez les familles examinées, tandis qu'une hérédité autosomique prédominante ou récessive, n'a pu être établie, mais ne peut être, d'autre part, exclue avec certitude

Le résultat des constatations basées sur le contenu des dossiers gé-

néalogiques ne permet donc pas de tirer des conclusions distinctes en ce qui concerne une forme quelconque d'hérédité.

D'après le développement de l'incidence dans le temps, il semble très probable qu'une facteur externe joue un rôle dans cette forme d'atrophie optique. Bien que la présence de cyanure dans le régime alimentaire ait été le seul facteur externe d'importance que j'ai pu constater, et celui-ci ne pouvant être d'autre part la seule cause de la pathologie (étant donné que la teneur en cyanure du régime alimentaire de la fraction indienne de la population est équivalente), on est fondé à penser qu'il existe dans la couche négroïde de la population du Suriname une prédisposition héréditaire.

Dans ce cas l'atrophie optique apparaîtrait seulement lorsque la condition du malade répond à ce facteur héréditaire et lorsque - de plus - le facteur exogène, par exemple sous la forme de phénomènes toxiques et/ou de déficiences, existe.

Il est impossible de tirer des conclusions définitives en se basant sur ces recherches, qui - de par les circonstances - ont forcément été limitées.

La cassave est un aliment qui continuera très certainement à jouer un rôle important dans l'alimentation des habitants des pays tropicaux, et il est essentiel de s'assurer de la toxicité de cette plante en cas de préparation inadéquate à la consommation.

Il est souhaitable, que les recherches dans ce domaine se poursuivent au Suriname. Ces recherches devraient être axées principalement sur les Marrons, car il a été démontré que l'incidence de l'atrophie optique est très élevée dans cette couche de la population, qu'elle n'est certainement pas susceptible de regresser, mais pourrait même se développer.

Tout en tenant compte des possibilités, il sera nécessaire de poursuivre des recherches en ce qui concerne l'hérédité. En outre, il sera également nécessaire d'effectuer des analyses concernant la teneur du sérum en diverses vitamines, y compris en Vit. B_{12}.

Il sera nécessaire également d'établir la teneur en acides aminés sulphuriques dans le régime et le sérum, la teneur en glutathion des érythrocytes, ainsi que la teneur en thio-cyanate du sérum et de l'urine, aussi bien chez les malades, que chez les personnes saines des groupes respectifs de la population.

Comme je l'ai déjà fait remarquer, je me suis trouvé, par suite de circonstances d'ordre pratique, dans l'impossibilité de poursuivre les recherches dans ces domaines. Mais il y a maintenant plus de 130.000

immigrés du Suriname aux Pays-Bas, et ce nombre augmentera encore.

Pour cette raison il a été demandé, d'une part par lettre circulaire aux ophtalmologues des Pays-Bas et, d'autre part, par une publication (Hendrikse, 1979) de transmettre à notre Faculté les donées relatives aux malades du Suriname résidant aux Pays-Bas et atteints de troubles d'atrophie optique bilatérale du segment temporal de la papille.

A l'avenier il nous sera probablement possible de signaler d'autres particularités de cette maladie, basées sur des recherches poursuivies chez ces malades.

Desde 1974 hasta mediados de 1977 se realizó en Surinama una investigación retrospectiva de archivo y una investigación en el campo hacia la frecuencia, forma de aparición y etiología de la atrofia óptica.

La atrofia óptica se encuentra muy frecuentemente en Surinama.

De la cantidad de pacientes de policlínica del Hospital Académico de Paramaribo en los cuales se ha encontrado atrofia óptica en el período comprendido entre 1950 hasta 1976, fueron 2360 Criollos, 441 Cimarrones, 830 Hindúes y 122 de otros grupos de población. Una explicación para la atrofia óptica pudo ser hallada para los Criollos en 12.6%, para los Cimarrones en 13.1%, para los Hindúes en 26.5% y para otros grupos de población en promedio de 39.6% de los casos. Ha quedado un grupo de pacientes con una atrofia óptica bilateral de causa desconocida y también un grupo con un cuadro que fué sospechoso de atrofia óptica bilateral y en el cual tampoco se pudo encontrar ninguna explicación.

De los casos de atrofia óptica correspondió a una atrofia óptica bilateral de causa desconocida, a los Criollos 58.8%, a los Cimarrones 66.7% y a los Hindúes 36.0%. Estos porcentajes fueron para los casos sospechosos de atrofia óptica bilateral respectivamente 21.0%, 13.6% y 29.4%. Atrofia óptica bilateral de causa desconocida ocurre principalmente en Criollos y Cimarrones y mucho menos en los Hindúes. En los otros grupos de población ocurre esta forma de atrofia óptica solo esporádicamente. La incidencia más alta de atrofia óptica bilateral de causa desconocida se encuentra en los distritos de Para y Saramacca. No hay diferencia en su aparición entre hombres y mujeres.

Con respecto al tiempo, hay un retroceso de la incidencia de atrofia óptica bilateral en los criollos, un posible aumento de ésta en los Cimarrones y desde 1963 ha permanecido prácticamente igual en los Hindúes. En casi todos los casos se trata de una neuropatía óptica caracterizada por una atrofia temporal de la papila.

En la gran mayoría de los pacientes de la investigación retrospectiva del archivo no se han constatado alteraciones de la retina. En los pacientes examinados en la práctica, se observaron regularmente muy pequeñas alteraciones de pigmento en la mácula y algún adelgazamiento de las arterias.

* Traduvido al espagñol por la señora N.G. van Moll-Ramírez.

Parecía que la agudeza visual dentro de un mismo grupo de atrofia óptica, podía variar fuertemente. De los pacientes criollos con atrofia óptica bilateral de causa desconocida, tienen aproximadamente 25% una agudeza visual menor de 0.1 y aproximadamente 50% una agudeza visual menor de 0.5. Con los Cimarrones son estos porcentages 40% y 70% respectivamente. De todos los pacientes de la investigación de archivo con atrofia óptica bilateral de causa desconocida se consideró al 13% como ciego legal (con una agudeza visual bilateral $\leq$ 3/60).

En prácticamente todos los pacientes con atrofia óptica bilateral de causa desconocida y en el 75% de los pacientes con sospecha de atrofia óptica se encontraron alteraciones del campo visual. Una alteración específica no fué detectada.

En la mayoría se trataba de una combinación de disminución general de la sensibilidad con escotomas paracentrales y centrales absolutos y/o relativos, con limitaciones variables del campo visual periférico y agrandamiento de la mancha ciega. Reacciones patológicas evidentes de la pupila no fueron observadas.

En la categoría de atrofia óptica bilateral y en los con sospecha de atrofia óptica bilateral, no se midió elevación de la presión intraocular.

En el grupo arbitrario de pacientes con atrofia óptica bilateral se encontró en el 41% de los casos, trastornos de la visión de colores. En el 27% de estos pacientes se trataba de una combinación de un defecto rojo-verde con un defecto azul-amarillo y en el 13% de un transtorno puro rojo-verde. En el grupo de pacientes genéticamente estudiados se encontró en el 14% trastornos puros rojo-verde. Una combinación de un defecto rojo-verde con un defecto azul amarillo no se observó en este grupo.

En solo un paciente del grupo B se encontró un defecto puro azul-amarillo.

Se encuentra que la atrofia óptica bilateral de causa desconocida es muy frecuente conforme aumenta la edad. Se ha constatado un gran aumento de la cantidad de pacientes cerca de los 40 años de edad. En más del 50% de los pacientes, los defectos visuales se iniciaron entre los 30 y 50 años de edad. En todos los casos se trataba de una disminución progresiva de la agudeza visual.

Esta atrofia óptica bilateral que se encuentra en Surinam, se distingue de la atrofia óptica comparable descrita en Jamaica y Africa occidental, entre otros, por la edad y la forma de originarse. En base

del cuadro clínico, examen serológico y datos anamnésicos, se pudieron excluir muchas causas neurológicas, neuroretinales e infecciosas (específicamente lúes).

Varias causas vasculares y hereditarias parecieron no ser de importancia etiológica. También la mayoría de las intoxicaciones podían ser excluidas. Se ha demostrado que en la población examinada hay una absorción considerable de substancias que contienen cyanuro. En base de una investigación de la alimentación, no es probable que exista un verdadero deficit en vitaminas o proteínas en la población criolla examinada.

En la alimentación de los grupos examinados de la población indígena, habían muchos substancias que contenían cyanuro. En ellos casi no se han visto atrofias ópticas. Por esto parece que no puede existir una simple relación entre la absorción de cyanuro y atrofia óptica. Tambien en base de un examen de la dieta, respecto al contenido de vitaminas y proteínas, no se pudo demostrar ninguna diferencia grande entre la población de Criollos e Indios.

Hay una apariencia familiar de esta patología en el grupo criollo examinado en el distrito de Para. Una herencia ligada al sexo se puede excluir en las familias por mí examinadas, mientras que no se puede demostrar pero tampoco excluir con seguridad una herencia autosomal dominante o recesiva. Los resultados de genética no dejan sacar entonces conclusiones claras sobre alguna forma de herencia. El transcurso de la incidencia con la edad, hace muy probable que un factor externo influya en esta atrofia óptica. La presencia de cyanuro en la dieta es el único factor externo de importancia que yo pude encontrar, pero este factor solo no puede ser la causa de la patología (tambien en los grupos de población de indios se encuentra igual volumen de cyanuro en la dieta), es posible que en el grupo de población negroide de Surinam exista una predisposición hereditaria. La atrofia óptica solo aparecerá cuando se cumple este factor hereditario y además cuando esté presente el factor exógeno en la modalidad de por ejemplo momentos tóxicos y/o deficiencias.

Con la ayuda de una classificacíon propia de atrofia optica se ha controbado los hallazgos clinicos de la investigacíon de campo.

En base de esta investigación, que por fuerzas de las circunstancias ha quedado limitada, todavía no se pueden hacer conclusiones definitivas sobre esta materia.

Como es seguro que el casabe como producto alimenticio en las esferas tropicales no baja de importancia, se tendría que obtener la

seguridad sobre la toxicidad de este cultivo en caso de su preparación incorrecta.

Es recomendable que en Surinam se realizaran más investigaciones en este campo. Estas investigaciones tendrían que enfocarse especialmente hacia los Cimarrones, pues se demostró que en este grupo de población la incidencia de la atrofia óptica es grande y de cualquier manera no baja y aún más al contrario posiblemente aumenta.

Por tanto que sea posible, se deberían realizar más investigaciones de herencia. Además se tendrían que llevar a cabo análisis exactos del contenido de diferentes vitaminas (inclusive vitamina B_{12}) en el suero.

Tambien se tendría que detectar el contenido de aminoácidos sulfurizados en la dieta y en el suero, tambien el contenido de glutatos de los eritrocitos y el contenido de tiocianatos del suero y orina, tanto en pacientes como en personas sanas de los grupos concernientes.

Como antes ya fué indicado me fué imposible por varias razones de carácter práctico, realizar esta investigación en forma amplia. No obstante hay en este momento por lo menos 130,000 inmigrantes de Surinam en Holanda y esta cantidad aún aumentará. Por esta razón se ha solicitado a los oftalmólogos que trabajan en Holanda se sirvan enviarnos datos sobre estos pacientes surinameses con atrofia óptica bilateral (Hendrikse 1979).

Posiblemente en el futuro podremos anotar más pormenores, mediante investigaciones que realizaremos a estos pacientes en Holanda.

Column number

1 - sex
- 1 – male
- 2 I female

2 - type of OA
- 1 explained
- 2 – unexplained

3 - age in years

4 - optic disc OD
- 1 temporal pallor
- 2 – total pallor
- 3 suspected
- 4 not interpretable
- 5 – prosthesis (trauma)
- 6 – no abnormality

5 - optic disc OS
- 1 – temporal pallor
- 2 total pallor
- 3 – suspected
- 4 not interpretable
- 5 – prosthesis (trauma)
- 6 – no abnormality

6 - visual acuity OD

7 - visual acuity OS

8 - pupillary reactions
- 1 – no abnormality
- 2 – very slow
- 3 – some symmetrical escape
- 4 – swinging flashlight phenomenon pos
- 5 – OS direct + indirect negative
  OD no abnormality

9 - intraocular pressure OD in mm Hg
- 0 not measured
- 00 – prosthesis
- 01 leucoma no palpable increase

10 - intraocular pressure OS in mm Hg
- 0 not measured
- 00 – prosthesis
- 01 – leucoma no palpable increase

11 - retina OD
- 1 – no abnormality
- 2 – macular degeneration
- 3 slight pigment changes in macular region
- 4 – constricted arteries
- 5 peripapillary pigment changes
- 6 – marked sclerosis of choriodea
- 7 – occluded venous branch
- 8 – chorioretinitis scar
- 9 – not interpretable
- 10 – prosthesis (trauma)

12 retina OS
- 1 – no abnormality
- 2 – macular degeneration
- 3 – slight pigment changes in macular region
- 4 – constricted arteries
- 5 peripapillary pigment changes
- 6 – marked sclerosis of choriodea
- 7 occluded venous branch
- 8 – chorioretinitis scar
- 9 – not interpretable
- 10 prosthesis (trauma)

13 general sensitivity OD
- 0 – not determined
- 1 yes
- 2 no

14 - general sensitivy OS
- 0 – not determined
- 1 yes
- 2 no

15 - central scotoma OD
- 0 – not determined
- A – absolute
- R – relative
- 2 absent

16 central scotoma OS
- 0 not determined
- A absolute
- R – relative
- 2 – absent

17 - paracentral scotoma OD
- 0 not determined
- A absolute
- R relative
- 2 absent

18 - paracentral scotoma OS
0 – not determined
A – absolute
R – relative
2 – absent

19 - peripheral limitation OD
0 - not determined
1 yes
2 – no

20 - peripheral limitation OS
0 – not determined
1 – yes
2 no

21 - enlarged blind spot OD
0 - not determined
1 – yes
2 – no

22 - enlarged blind spot OS
0 – not determined
1 – yes
2 – no

23 - WR
0 – not determined
1 – positive
2 – negative

24 - VDRI
0 = not determined
1 - positive
2 – negative

25 - FTA-abs test
0 – not determined
1 – positive
2 – negative

26 - decrease in visual acuity
0 – no anamnestic evidence
1 - gradual
2 - acute

27 - estimated age at onset decrease visual acuity
0 – not applicable

28 - neurological disorders
1 none
2 – conduction hearing defect
3 - low reflexes
4 - intention tremor hands
5 – facial paresis (unilateral)
6 – distal paresis lower legs (see text)
7 – sensorineural hearing defect

x^1 - large physiological cup
x^2 - nuclear cataract
x^3 - centrocaecal scotoma

GROUP A Random patients with unexplained pallor of optic disc

	column number																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
pat nr																												
1	1	2	35	2	2	4/60	2/10	3	18	16	3	3	1	1	2	2	A	2	1	2	2	2	2	2	0	1	25	1
2	2	2	60	2	2	5/60	5/60	2	13	14	1	1	1	1	2	2	A	A	1	1	1	1	2	2	0	1	40	3
3	2	2	46	1	1	1/2	7/10	1	17	18	3 5	3 5	1	2	2	2	2	2	2	2	2	2	0	1	2	1	36	3
4	2	2	54	1	1	1/4	3/4	2	0	0	3 4	3 4	0	0	0	0	0	0	0	0	0	0	0	2	0	1	51	1
5	2	2	60	1	1	1/2	3/4	1	11	13	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0	1	55	1
6	1	2	59	2	2	2/60	3/60	2 3	10	12	3 4	3 4	1	1	2	2	2	A	1	1	2	2	2	2	0	1	34	7
7	1	2	67	2	2	9/10	9/10	1	14	16	4 5	4 5	1	1	2	2	2	2	2	2	2	1	2	2	0	0	0	7
8	2	2	52	3	1	7/10	2/10	1	15	15	3 4	3 4	0	0	0	0	0	0	0	0	0	0	0	2	0	1	47	3
9	1	2	61	1	1	7/10	1-2/10	1	14	14	3 4	3 4	1	1	2	2	2	2	1	1	2	1	0	2	0	1	38	2

pat nr	column number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
10	1	2	57	1	3	2/10	9/10	1	16	16	3	3	1	1	2	2	2	2	1	2	2	2	2	2	0	1	42	3
11	1	2	67	1	1	2/60	4/60	2 3	10	12	4 5 3	4 5 3	1	1	R	R	R	R	2	2	2	1	0	2	0	1	37	2 3
12	2	2	63	3	1	3/60	3/60	1	18	17	4	4	1	1	2	2	2	2	1	1	2	1	2	2	0	1	48	3 7
13	2	2	53	1	1	10/10	10/10	1	17	14	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	1
14	1	2	62	1	1	1/10	10/10	1	14	12	1	1	1	1	2	2	A	2	1	1	2	2	2	2	0	1	56	1
15	2	2	44	1	1	1/3	1/2	1	12	12	1	1	0	0	0	0	0	0	0	0	0	0	2	2	0	1	34	1
16	1	2	76	1	1	3/60	5/60	1	12	9	4 5	4 5	0	0	0	0	0	0	0	0	0	0	2	2	0	1	56	3 7

GROUP B Family study patients with unexplained pallor of optic disc

1	2	2	48	1	2	10/10	10/10	1	11	11	1	1	1	1	2	2	R	R	1	1	2	2	2	2	0	0	0	1
2	2	2	43	3	1	9/10	10/10	1	12	12	1	1	2	2	2	2	2	2	2	2	1	1	0	2	0	1	41	1
3	1	2	24	1	1	8/10	8/10	1	14	15	5	5	2	2	2	2	2	2	2	2	2	1	0	2	0	0	0	1
4	1	2	27	3	1	12/10	12/10	1	16	16	1	1	2	2	2	2	2	2	2	1	1	1	0	2	0	0	0	1
5	1	2	52	1	1	12/10	12/10	1	13	13	3	3	2	2	2	2	2	2	2	2	1	1	0	2	0	0	0	4
6	1	2	83	2	5	6/300	0	1	17	00	3 4 6	10	0	0	0	0	0	0	0	0	0	0	0	2	0	1	70	3 2
7	1	2	76	1	4	4/60	1/00	5	11	49	3 4	9	0	0	0	0	0	0	0	0	0	0	0	2	0	1	56	3
8	2	2	38	1	1	5/10	15/10	1	15	15	4 5	4 5	1	2	2	2	2	2	1	1	1	2	0	2	0	0	15	1
9	2	2	45	2	1	3/10	3/10	1	10	10	5	5	1	1	2	2	A	R	2	2	1	1	0	2	0	1	37	1
10	2	2	44	1	1	7/10	8/10	1	15	15	1	1	1	1	2	2	R	2	1	1	1	1	0	2	0	0	0	1
11	1	2	69	1	1	1/4	1/6	1	12	14	1	1	1	1	2	2	2	2	1	1	2	2	2	2	0	1	59	3 7
12	1	2	70	1	1	6/60	0 5/60	1	14	13	4	4	1	0	A[3]	0	R[3]	0	2	0	2	0	0	1	1	1	63	2 3 7
13	2	2	72	1	4	5/10	1/00	1	17	01	4 6	9	1	0	2	0	2	0	1	0	2	0	0	2	0	1	42	3
14	1	2	45	1	1	10/10	8/10	1	11	10	1	1	1	1	2	2	2	2	2	2	2	1	0	2	0	1	43	1
15	1	2	70	1	1	5/60	5/60	1	17	16	1	1	1	1	2	R[3]	A	A	2	2	1	1	0	2	0	1	45	3 7
16	1	2	58	1	1	4/10	5/10	1	17	17	3 4	3 4	1	1	R	R	A	R	2	2	2	2	0	2	0	1	23	2
17	1	2	50	1	1	6/10	7/10	1	10	11	1	1	2	1	2	2	2	2	2	2	2	1	0	2	0	1	27	3
18	1	2	67	1	1	2/60	0 5/60	3	15	15	3 4	3 4	1	1	A	A	R[3]	R	1	2	2	2	0	2	0	1	57	6 7
19	1	2	42	2	2	15/10	15/10	1	11	11	1	1	1	1	2	2	2	2	2	1	2	2	2	2	0	0	0	1

pat nr	column number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
GROUP C Family study patients with suspected pallor of optic disc																												
1	2	2	77	3	3	1/4	1/6	3	11	12	4	4	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	37
2	2	2	43	3	3	8/10	8/10	1	14	14	1	8	1	1	2	2	2	R	2	1	2	2	0	2	0	1	33	1
3	1	2	42	3	3	5/4	5/4	1	10	10	4	4	2	2	2	2	2	2	1	1	2	2	2	2	0	0	0	1
4	1	2	18	3	3	12/10	12/10	1	15	15	1	1	2	2	2	2	2	2	2	2	2	1	0	2	0	0	0	1
5	2	2	14	3	3	12/10	15/10	1	14	14	1	1	2	2	2	2	2	2	2	2	2	2	0	2	0	0	0	1
6	1	2	49	3	3	8/10	10/10	1	21	22	1	1	1	1	2	2	R	2	2	2	1	2	0	2	0	0	0	1
7	2	2	38	3	3	15/10	15/10	1	14	14	1	1	2	2	2	2	2	2	2	2	2	2	0	2	0	0	0	1
8	2	2	55	3	3	10/10	10/10	1	15	15	1	1	1	1	2	2	2	2	2	2	2	1	0	1	2	1	53	1
9	2	2	30	3	3	10/10	10/10	1	17	17	1	1	2	2	2	2	2	2	1	2	2	1	0	2	0	0	0	1
10	2	2	9	3	3	10/10	10/10	1	12	12	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
11	1	2	15	3	3	5/4	5/4	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
GROUP D Normal optic disc																												
1	1		60	6[1]	6[1]	5/10	6/10	1	16	17	1	1	2	2	2	2	2	2	2	2	2	1	0	2	0	0	0	1
2	1		20	6[1]	6[1]	12/10	10/10	1	17	18	1	1	2	2	2	2	2	2	2	2	2	2	0	2	0	0	0	1
3	2		50	6[1]	6[1]	8/10	10/10	1	15	15	1	1	1	2	2	2	2	2	2	2	2	2	0	2	0	1	38	1
4	1		58	6[2]	6[2]	4/60	[3] 4/60	1	18	18	4	4	0	0	0	0	0	0	0	0	0	0	1	1	1	1	33	37
5	1		62	6[2]	6	5/10	10/10	1	17	16	1	1	2	2	2	2	2	2	1	1	2	2	0	2	0	0	0	1
6	2		13	6	6	12/10	12/10	1	14	14	1	1	2	2	2	2	2	2	2	2	2	2	0	2	0	0	0	1
7	1		22	6[1]	6[1]	20/10	15/10	1	14	15	1	1	2	2	2	2	2	2	2	2	2	2	0	2	0	0	0	1
8	1		22	6[1]	6[1]	12/10	12/10	1	15	15	1	1	2	2	2	2	2	2	2	2	2	2	0	2	0	0	0	1
9	1		8	6	6	5/4	10/10	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
10	1	16	6	6	15/10	15/10	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	
11	2		14	6	6	15/10	15/10	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
12	2		8	6	6	10/10	10/10	1	12	12	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
GROUP F Explained pallor of optic disc																												
1	1	1	54	2	2	3/10	4/60	4	11	13	3 4	2 4	2	1	R	A	R	2	1	1	1	1	0	2	0	1	37	1
2	1	1	49	1	1	1/10	1/10	1	32	32	4	4 7	1	1	R[3]	R[3]	2	2	1	1	2	1	0	1	1	1	32	3
3	2	1	45	2	2	3/10	3/10	1	15	14	4 3 5	4 3 5	1	1	R	R[3]	2	2	2	2	2	2	0	1	1	1	35	1
4	2	1	74	2	2	3/60	4/60	2	35	38	4 8	4 8	0	0	0	0	0	0	0	0	0	0	0	2	0	1	59	2
5	2	1	32	6	1	15/10	4/60	1	15	16	1	8	2	0	2	0	2	0	2	0	2	0	0	2	0	1	27	1
6	1	1	58	1	1	1/3	1/2	2	14	13	4	4	1	1	2	2	2	2	1	1	1	1	2	2	0	1	33	3 5 7

ADDENDUM 2

Name	Father	Date of birth	Address
Maiden name	Mother	Age	Occupation

History
Previous consultation ophthalmologist if so, which
Visual acuity good / poor
Poor since
Onset of symptoms gradual / acute
Additional complaints yes / no
Any current disease yes / no
Under medical treatment yes / no
Diseases in the family yes / no
Diseases suffered in the past
Accidents (etc.)
Periods of serious food shortage yes / no
Food allergy yes / no
Smoking yes / no if so how much
Drinking yes / no, if so, how much
Definite neurological complaints (disturbed sensibility, tremors, muscular weakness, tingling sensations etc.)
Miscellaneous

Neurological examination
Masseter muscles atrophic yes / no
Masseter reflex present yes / no
Facial symmetry yes / no
Baring teeth good / poor
Closing eyes good / poor
Perception of whispers R good / poor L good / poor
Rinne's test R pos / neg L pos / neg
Weber's test lateralization yes / no
Schwabach's test R good / poor L good / poor
Pharyngeal arch symmetrical yes / no
Sternocleidomastoideus muscle good / poor
Abdominal reflex pos / neg
Involuntary movements yes / no
Tonicity arms normal yes / no
Atrophy arms yes / no
Tonicity legs normal yes / no
Atrophy legs yes / no
Finger nose test good / poor
Knee heel test good / poor
Diadochokinesis good / poor
Tremors yes / no
Intention tremors yes / no
Knee-jerk L and R good yes / no
Achilles tendon reflex L and R good yes / no
Plantar reflex Strumpell/Babinski/indifferent L – R yes / no
Romberg's sign pos neg
Walking on toes good / poor
Walking on heels good / poor
Standing on one leg L R yes / no

Ophthalmological examination
VOD uncorrected

corrected
visual acuity
VOS uncorrected
corrected
visual acuity
Retinoscopy OD OS
Media OD OS
Pupil OD OS
Movements OD OS
Nystagmus yes / no
Intraocular pressure OD OS
Funduscopy under mydriasis
optic disc OD OS
vessels OD OS
retina OD OS
Colour vision
AO H-R-R.
Farnsworth Panel D-15
Visual fields (Goldmann).
Serology
WR ·
VDRL ·
FTA-abs ·

Results of the colour vision tests

Test codes

AO H-R-R test

S 1, 2, 3 etc	– screening errors
A	– analysis, this concerns diagnostic plates
Px	– protan, with number of erroneously read plate
Dx	– deutan, with number of erroneously read plate
Tx	– tritan, with number of erroneously read plate
T+x	tetartan, with number of erroneously read plate
No	– normal
I	– test impracticable (poor cooperation or inability to denominate hues)

Panel D-15 test

No	– normally placed
xME	– x minor errors, e g two consecutive caps exchanged
x//P	– x errors parallel to protan axis
x//D	– x errors parallel to deutan axis
x//T	– x errors parallel to tritan axis
x//T	= x errors parallel to tetartan axis
x// PD	– x errors parallel to axis between protan and deutan
x// DT	– x errors parallel to axis between deutan and tritan
C// P, etc	– everything is placed parallel to protan axis
x	– the axis direction varies
xx	– chaotic placement
MET	– several minor errors parallel to the tritan axis
MLT+	– several minor errors parallel to tetartan axis
I	– test is impracticable (poor cooperation or inability to denominatehues)

Group A

pat nr	AO H-R-R	Panel D-15
1 OD	S1/6AP7/16D7/16T17, 18T+17, 19	x1//T + P, 2//PD, 2//DT
OS	S1/6AP7/16D7/16T17, T+17, 19	3//D, 1//DT
2 ODS	S1/3, 6AP7, 9D12T+, 18	4//T
3 OD	S1/4, 6 AP7 D7	MET
OS	S2/4,6 AP7 T17 T+17	MET
4 OD	S3	1 ME
OS	No	MET
5 OD	No	1ME
OS	No	No
6 OD	I	x2//T P, 1//D, 3//DT
OS	I	x1//T+P, 1//PD, 5//D
7 OD	No	No
OS	No	1ME
8ODS	S2	2//T+P, 1//T, 1//T+
9 OD	S1/6 AP7/10	No
OS	S1/6 AP/10, 12, D7/11, 15	1ME
10 ODS	S2	1//T+, 3 ME
11 OD	I	I
OS	I	I

12 OD	S1/4, 6 AP7,9,12, D7, T20, T+18	x 2//DT, 3//T
OS	S1/4, 6 AP7,9,12,D7,T17,18T+,7,18	x 1//T P, 3//T
13 OD	No	No
OS	No	No
14 OD	No	1//PD, 2ME
OS	No	No
15 OD	I	I
OS	I	I
16 ODS	S2,3	2ME

Group B

pat nr	AO H-R-R	Panel D-15
1 OD	No	No
OS	No	No
2 OD	S3	No
OS	S3	No
3 OD	No	No
OS	No	No
4 OD	No	No
OS	No	No
5 OD	S3, 6	No
OS	No	No
6 OD	I	I
OS	I	I
7 OD	I	I
OS	I	I
8 OD	No	No
OS	No	No
9 OD	S3, 4, 6	1//T+P, 1//T-
OS	S3, 4	1//T+P, 1 ME
10 OD	S2/4	No
OS	S2, 3, 6	MET
11 ODS	No	1//T, 2ME
12 ODS	S1, 3, 6	x2//DT, 1//T, 1//T+
13 ODS	S2	1//T, 1ME
14 OD	S2/4, AP7, D7	x3//T+P, 1//D, 1ME
OS	S2/4, 6AP7, 9, D7	1//T+P, 1//P, 3ME
15 ODS	S2/4	No
16 OD	S2/4, AP7/9, D7/9	1//T-P, 1//DT, 1//T+, 3ME
OS	S2/4, 6AP7, 9 D7, 8, 13	1//T+P, 1//DT, 3ME
17 OD	S2, 3	1//T, 1ME
OS	S2, 3 AT+ 18, 20	3 ME
18 OD	No	I
OS	No	I
19 ODS	S3	No

Group C

pat nr	AO H-R-R	Panel D-15
1 OD	No	No
OS	S2	No
2 OD	No	1ME
OS	No	2ME
3 ODS	No	1//T

4 OD	S3	No
OS	No	No
5 OD	No	No
OS	No	No
6 OD	S1/4, 6	1//P, 1//D
OS	S3,4,6 A D7	1//P, 1//PD, 1//DT
7 OD	No	No
OS	No	No
8 OD	S3	1 ME
OS	S3	1 ME
9 OD	No	1 ME
OS	No	1//T+
10 OD	I	I
OS	I	I
11 ODS	No	1 ME

Group D

1 OD	S3	No
OS	No	No
2 OD	No	No
OS	No	1 ME
3 OD	No	1//T
OS	No	No
4 OD	No	No
OS	No	No

In addition, 12 eyes with normal OA H-R-R and Panel D-15

Group E

pat nr	AO H-R-R	Panel D-15
1 OD	S2/4,6	1 ME
OS	S 4, 6 AP 7	3//T
2 OD	S2/4, 5 AP 7/9 D 7, 9	2//T P, 2 ME
OS	cS1/4, 6 AP 7/9 D 7,8	2 ME
3 OD	I	1/T+, 3 ME
OS	I	4/T, 1/T+
4 OD	I	I
OS	I	I
5 ODS	No	No
6 ODS	No	1/T+, 1 ME

Additional data of pedigree A

A III 3 Deceased at age 30 after years of paralysis.
A III 5 Deceased after acute abdominal disease
A III 7 Drowned
A III 8 Deceased after snake-bite.
A III 9 Deceased from complications of artificial abortion.
A III 10 Glaucoma
A III 11 Deceased at age 15 after years of illness(?)
A III 12. Deceased from pneumonia in asthmatic bronchitis.
A III 15 Glaucoma

A IV 2 Large physiological cup
A IV 7 Deceased after abdominal disease
A IV 8· Deceased from infectious disease.
A IV 13· Large physiological cup.
A IV 14· Large physiological cup.
A IV 15. Deceased from overdose of anthelmintic.
A IV 18 Deceased from burns
A IV 19. Drowned
A IV 20 Deceased after four days of infectious disease
A IV 21 Deceased after motoring accident.
A IV 22 Large physiological cup.
A IV 29 Deceased at age 20 after epileptic seizures since age 13
A IV 33 Large physiological cup

A V 2 Large physiological cup
A V 3 Deceased at age 20, 'weak neck' and inability to stand since birth
A V 4 Large physiological cup
A V 7 Large physiological cup
A V 8· Deceased from pneumonia in asthmatic bronchitis
A V 12 Deceased from pneumonia
A V 14· Large physiological cup
A V 16· Microcephaly (with optic atrophy).

Additional data of pedigree B

B V 6· Stillborn.
B V 7· Stillborn.
B V 11: Glaucoma.
B V 14. Large physiological cup.
B V 16· Deceased after traffic accident.
B V 17 Large physiological cup.
B V 18 Large physiological cup
B V 20 Large physiological cup
B V 21 Large physiological cup

B VI 1 Deceased from pneumonia in asthmatic bronchitis (age 5).
B VI 2 Deceased from typhoid fever (age 1).
B VI 3 Large physiological cup.
B VI 4. Deceased from diarrhoea at age 1.
B VI 5. Deceased from diarrhoea at age 1.
B VI 6. Deceased from diarrhoea at age 1.
B VI 7: Large physiological cup
B VI 8: Large physiological cup
B VI 9· (Deaf?)-mute
B VI 10· Death from 'infection' at age 21.

B VI 11 Death from 'infection' at age 3
B VI 12 Large physiological cup
B VI 13 Large physiological cup.
B VI 14 Large physiological cup
B VI 15 Large physiological cup.
B VI 16 Large physiological cup
B VI 17 Large physiological cup
B VI 18 Large physiological cup.
B VI 22 Large physiological cup.
B VI 23 Large physiological cup.
B VI 24 Large physiological cup.
B VI 25 Large physiological cup.

B VII 1 Large physiological cup
B VII 3 Large physiological cup.

ADDENDUM 5

Additional findings in groups I and II (the data on Creoles (C), Bush Negroes (BN) and Hindustani (H) have been lumped together because only very small differences were found between these races)

	I (N = 1697)	*II (N = 603)*
Constricted arteries/hypertensive retinopathy	225 (13 2 %)	53 (8 8%)
Gradually decreased visual acuity	134 (7 9 %)	35 (5 8%)
Acutely decreased visual acuity	12 (0' 7 %)	1 (0 2%)
Hearing defect	19 (1 1 %)	6 (1 0%)
Nystagmus	6 (0 3 %)	2 (0 3%)
Negative pupillary reactions	20 (1 2 %)	5 (0 8%)
High normal intraocular pressure	3 (0 2 %)	2 (0 3%)
Neurological disorders (various)	5 (0 3 %)	1 (0 2%)
Severe myopia	1 (0 06%)	– –
Tuberculosis	2 (0 1 %)	2 (0 3%)
Subsequent glaucoma	3 (0 2 %)	– –
Diabetes mellitus	5 (0 3 %)	10 (1 6%)
Syphilis	3 (0 2 %)	– –
Miscellaneous	257 (15 1 %)	78 (13 0%)
Total	695 (40 9 %)	195 (32 3%)

ADDENDUM 6

Additional findings in group IV, classified by race The parameters marked with an asterisk were accepted as explanation of the optic atrophy involved

	C (N = 275)	*BN (N = 53)*	*H (N = 203)*
Constricted arteries/hypertensive retinopathy	13 (4 7%)	--	5 (2 5%)
Gradually decreased visual acuity	7 (2 5%)	--	2 (1 0%)
Acutely decreased visual acuity	--	--	1 (0 5%)
Defective hearing	--	--	2 (1 0%)
Trauma*	35 (12 7%)	7 (13 2%)	37 (18 2%)
Hydrocephalus*	9 (3 3%)	--	6 (2 9%)
Epilepsy	4 (1 4%)	--	--
Encephalitis*	2 (0 7%)	7 (13 2%)	--
Neurosyphilis*	5 (1 8%)	1 (1 9%)	1 (0 5%)
Brain tumour*	10 (3 6%)	--	21 (10 3%)
Toxicosis*	4 (1 4%)	--	8 (3 9%)
Eclampsia*	2 (0 7%)	--	6 (2 9%)
Negative pupillary reactions	8 (3 0%)	3 (5 7%)	4 (2 0%)
Exophthalmos*	--	1 (1 9%)	--
Retrobulbar phlegmon*	1 (0 4%)	--	--
Unilateral glaucoma	1 (0 4%)	--	--
High normal intraocular pressure	1 (0 4%)	1 (1 9%)	--
Neurological disorders (various)*	28 (10 2%)	2 (3 8%)	31 (15 3%)
Retrobulbar neuritis*	7 (2 5%)	--	3 (1 5%)
Tuberculosis	--	--	1 (0 5%)
Syphilis	--	1 (1 9%)	--
Orbital process*	4 (1 4%)	--	--
Diabetes	1 (0 4%)	--	--
Choked disc*	2 (0 7%)	--	1 (0 5%)
Abundant blood loss*	1 (0 4%)	--	--
Tapetoretinal degeneration*	2 (0 7%)	4 (7 5%)	2 (1 0%)
Miscellaneous	44 (16 0%)	12 (22 6%)	26 (12 8%)
Total	191 (72 4%)	39 (73 6%)	157 (77 3%)

CURRICULUM VITAE

Fred Hendrikse werd op 9 januari 1947 geboren te Singapore. Na het behalen van het eindexamen H.B.S.-B aan het Zaanlands Lyceum te Zaandam, ging hij in 1967 medicijnen studeren aan de Medische Faculteit te Rotterdam waar hij het artsexamen behaalde op 16 november 1973.

Vanaf januari 1974 was hij als arts in algemene dienst verbonden aan het Ministerie van Volksgezondheid in Suriname.

Tot juli 1975 was hij werkzaam op een rijdende oogpolikliniek (toen onderdeel van de polikliniek oogheelkunde van het Academisch Ziekenhuis te Paramaribo, hoofd: H. L. A. Kleine, oogarts) en tot februari 1977 als districtsarts in het district Nickerie.

Tot juli 1977 verbleef hij in het district Para om het veldonderzoek, dat in dit proefschrift beschreven wordt, te voltooien (in samenwerking met de discipline oogheelkunde van de Universiteit van Suriname, hoofd: Prof. dr. A.C. Breebaart).

Vanaf 1 september 1977 specialiseert hij zich tot oogarts onder leiding van Prof. dr. A. F. Deutman in de oogheelkundige kliniek van het St. Radboud Ziekenhuis van de Universiteit van Nijmegen.

I

In Suriname komt bilaterale opticusatrofie bij Creolen en Bosnegers aanzienlijk meer voor dan bij de overige bevolkingsgroepen.

II

Bilaterale opticusatrofie bij de onderzochte Creolen in het district Para wordt niet X-chromosomaal overgeërfd.

III

De meeste eindproducten van cassave, zoals die door de onderzochte Creoolse en Indiaanse populaties worden bereid, bevatten niet te verwaarlozen hoeveelheden cyanidehoudende bestanddelen.

IV

In Suriname ligt lues slechts zelden ten grondslag aan opticusatrofie.

V

De gezichtsscherpte is niet het enige functionele criterium voor opticusatrofie.

VI

De in Suriname bij Creolen veel voorkomende bilaterale opticusatrofie wordt mede veroorzaakt door een uitwendige factor.

VII

Classificatie van opticusatrofie op basis van klinische of pathologisch anatomische criteria is niet zinvol.

VIII

Iedere verworven protrusio bulbi bij een kind dient binnen 48 uur multidisciplinair geëvalueerd te worden.

IX

Framboesia tropica (yaws) is in Suriname nog endemisch.

X

Er dient onderzoek te worden verricht naar het voorkomen van intracraniele tumoren bij de Hindoestaanse bevolkingsgroep van Suriname.

XI

Aan ieder manifest strabisme bij een jong kind ligt een retinoblastoom ten grondslag tenzij het tegendeel is bewezen.

XII

Bij een proliferatieve diabetische retinopathie dient in het vroegste stadium met lichtcoagulatie te worden begonnen.

XIII

Sinusitis speelt bij de aetiologie van opticusatrofie in het algemeen geen rol van betekenis.

XIV

Na een perforerend oculair trauma dient, bij juiste indicatiestelling, binnen twee weken trans pars plana vitrectomie verricht te worden.

XV

De geplande capaciteit van de Brokopondo Krachtcentrale wordt onder meer niet bereikt door wildgroei van de waterhyacint (Eichhornia Crassipes) in het Prof. Dr. Ir. W.J. van Blommesteinmeer.

XVI

Bij de selectie van de ontwikkelingswerkers naar landen in de tropen dienen personen met een lichte vorm van de ziekte van Raynaud een voorkeursbehandeling te krijgen.

XVII

Dwarsfluiten met een origineel Boehm mechaniek verdienen de voorkeur boven instrumenten met een bes-klep volgens Briccialdi.